PRACTICE PROBLEMS

1 Given spot rates for one-, two-, and three-year zero coupon bonds, how many forward rates can be calculated?

2 Give two interpretations for the following forward rate: The two-year forward rate one year from now is 2%.

3 Describe the relationship between forward rates and spot rates if the yield curve is flat.

4 **A** Define the yield to maturity for a coupon bond.

B Is it possible for a coupon bond to earn less than the yield to maturity if held to maturity?

5 If a bond trader believes that current forward rates overstate future spot rates, how might he or she profit from that conclusion?

6 Explain the strategy of riding the yield curve.

7 What are the advantages of using the swap curve as a benchmark of interest rates relative to a government bond yield curve?

8 Describe how the Z-spread can be used to price a bond.

9 What is the TED spread and what type of risk does it measure?

10 According to the local expectations theory, what would be the difference in the one-month total return if an investor purchased a five-year zero-coupon bond versus a two-year zero-coupon bond?

11 Compare the segmented market and the preferred habitat term structure theories.

12 **A** List the three factors that have empirically been observed to affect Treasury security returns and explain how each of these factors affects returns on Treasury securities.

B What has been observed to be the most important factor in affecting Treasury returns?

C Which measures of yield curve risk can measure shaping risk?

13 Which forward rate cannot be computed from the one-, two-, three-, and four-year spot rates? The rate for a:

A one-year loan beginning in two years.

B two-year loan beginning in two years.

C three-year loan beginning in two years.

14 Consider spot rates for three zero-coupon bonds: $r(1) = 3\%$, $r(2) = 4\%$, and $r(3) = 5\%$. Which statement is correct? The forward rate for a one-year loan beginning in one year will be:

A less than the forward rate for a one-year loan beginning in two-years.

B greater than the forward rate for a two-year loan beginning in one-year.

C greater than the forward rate for a one-year loan beginning in two-years.

15 If one-period forward rates are decreasing with maturity, the yield curve is *most likely*:

A flat.

B upward-sloping.

C downward sloping.

The following information relates to Questions 16–29

A one-year zero-coupon bond yields 4.0%. The two- and three-year zero-coupon bonds yield 5.0% and 6.0% respectively.

16 The rate for a one-year loan beginning in one year is *closest* to:

A 4.5%.

B 5.0%.

C 6.0%.

17 The forward rate for a two-year loan beginning in one year is *closest* to:

A 5.0%.

B 6.0%.

C 7.0%.

18 The forward rate for a one-year loan beginning in two years is *closest* to:

A 6.0%.

B 7.0%.

C 8.0%.

19 The five-year spot rate is not given above; however, the forward price for a two-year zero-coupon bond beginning in three years is known to be 0.8479. The price today of a five-year zero-coupon bond is *closest* to:

A 0.7119.

B 0.7835.

C 0.9524.

20 The one-year spot rate $r(1) = 4\%$, the forward rate for a one-year loan beginning in one year is 6%, and the forward rate for a one-year loan beginning in two years is 8%. Which of the following rates is *closest* to the three-year spot rate?

A 4.0%

B 6.0%

C 8.0%

21 The one-year spot rate $r(1) = 5\%$ and the forward price for a one-year zero-coupon bond beginning in one year is 0.9346. The spot price of a two-year zero-coupon bond is *closest* to:

A 0.87.

B 0.89.

C 0.93.

22 In a typical interest rate swap contract, the swap rate is *best* described as the interest rate for the:

A fixed-rate leg of the swap.

B floating-rate leg of the swap.

C difference between the fixed and floating legs of the swap.

23 A two-year fixed-for-floating Libor swap is 1.00% and the two-year US Treasury bond is yielding 0.63%. The swap spread is *closest* to:

A 37 bps.

B 100 bps.

C 163 bps.

24 The swap spread is quoted as 50 bps. If the five-year US Treasury bond is yielding 2%, the rate paid by the fixed payer in a five-year interest rate swap is *closest* to:

A 0.50%.

B 1.50%.

C 2.50%.

25 If the three-month T-bill rate drops and the Libor rate remains the same, the relevant TED spread:

A increases.

B decreases.

C does not change.

26 Given the yield curve for US Treasury zero-coupon bonds, which spread is *most* helpful pricing a corporate bond? The:

A Z-Spread.

B TED spread.

C Libor–OIS spread.

27 A four-year corporate bond with a 7% coupon has a Z-spread of 200 bps. Assume a flat yield curve with an interest rate for all maturities of 5% and annual compounding. The bond will *most likely* sell:

A close to par.

B at a premium to par.

C at a discount to par.

28 The Z-spread of Bond A is 1.05% and the Z-spread of Bond B is 1.53%. All else equal, which statement *best* describes the relationship between the two bonds?

A Bond B is safer and will sell at a lower price.

B Bond B is riskier and will sell at a lower price.

C Bond A is riskier and will sell at a higher price.

29 Which term structure model can be calibrated to closely fit an observed yield curve?

A The Ho–Lee Model

B The Vasicek Model

C The Cox–Ingersoll–Ross Model

The following information relates to Questions 30–36

Jane Nguyen is a senior bond trader and Christine Alexander is a junior bond trader for an investment bank. Nguyen is responsible for her own trading activities and also for providing assignments to Alexander that will develop her skills and create profitable trade ideas. Exhibit 1 presents the current par and spot rates.

Exhibit 1 Current Par and Spot Rates

Maturity	Par Rate	Spot Rate
One year	2.50%	2.50%
Two years	2.99%	3.00%
Three years	3.48%	3.50%
Four years	3.95%	4.00%
Five years	4.37%	

Note: Par and spot rates are based on annual-coupon sovereign bonds.

Nguyen gives Alexander two assignments that involve researching various questions:

Assignment 1 What is the yield to maturity of the option-free, default risk–free bond presented in Exhibit 2? Assume that the bond is held to maturity, and use the rates shown in Exhibit 1.

Exhibit 2 Selected Data for $1,000 Par Bond

Bond Name	Maturity (*T*)	Coupon
Bond Z	Three years	6.00%

Note: Terms are today for a *T*-year loan.

Assignment 2 Assuming that the projected spot curve two years from today will be below the current forward curve, is Bond Z fairly valued, undervalued, or overvalued?

After completing her assignments, Alexander asks about Nguyen's current trading activities. Nguyen states that she has a two-year investment horizon and will purchase Bond Z as part of a strategy to ride the yield curve. Exhibit 1 shows Nguyen's yield curve assumptions implied by the spot rates.

30 Based on Exhibit 1, the five-year spot rate is *closest to*:

A 4.40%.

B 4.45%.

C 4.50%.

31 Based on Exhibit 1, the market is *most likely* expecting:

A deflation.

B inflation.

C no risk premiums.

32 Based on Exhibit 1, the forward rate of a one-year loan beginning in three years is *closest to*:

A 4.17%.

B 4.50%.

C 5.51%.

33 Based on Exhibit 1, which of the following forward rates can be computed?

A A one-year loan beginning in five years

B A three-year loan beginning in three years

C A four-year loan beginning in one year

34 For Assignment 1, the yield to maturity for Bond Z is *closest* to the:

A one-year spot rate.

B two-year spot rate.

C three-year spot rate.

35 For Assignment 2, Alexander should conclude that Bond Z is currently:

A undervalued.

B fairly valued.

C overvalued.

36 By choosing to buy Bond Z, Nguyen is *most likely* making which of the following assumptions?

A Bond Z will be held to maturity.

B The three-year forward curve is above the spot curve.

C Future spot rates do not accurately reflect future inflation.

The following information relates to Questions 37–41

Laura Mathews recently hired Robert Smith, an investment adviser at Shire Gate Advisers, to assist her in investing. Mathews states that her investment time horizon is short, approximately two years or less. Smith gathers information on spot rates for on-the-run annual-coupon government securities and swap spreads, as presented in Exhibit 1. Shire Gate Advisers recently published a report for its clients stating its belief that, based on the weakness in the financial markets, interest rates will remain stable, the yield curve will not change its level or shape for the next two years, and swap spreads will also remain unchanged.

Exhibit 1 Government Spot Rates and Swap Spreads

	Maturity (years)			
	1	2	3	4
Government spot rate	2.25%	2.70%	3.30%	4.05%
Swap spread	0.25%	0.30%	0.45%	0.70%

Smith decides to examine the following three investment options for Mathews:

Investment 1:	Buy a government security that would have an annualized return that is nearly risk free. Smith is considering two possible implementations: a two-year investment or a combination of two one-year investments.
Investment 2:	Buy a four-year, zero-coupon corporate bond and then sell it after two years. Smith illustrates the returns from this strategy using the swap rate as a proxy for corporate yields.
Investment 3:	Buy a lower-quality, two-year corporate bond with a coupon rate of 4.15% and a Z-spread of 65 bps.

When Smith meets with Mathews to present these choices, Mathews tells him that she is somewhat confused by the various spread measures. She is curious to know whether there is one spread measure that could be used as a good indicator of the risk and liquidity of money market securities during the recent past.

37 In his presentation of Investment 1, Smith could show that under the no-arbitrage principle, the forward price of a one-year government bond to be issued in one year is *closest* to:

A 0.9662.

B 0.9694.

C 0.9780.

38 In presenting Investment 1, using Shire Gate Advisers' interest rate outlook, Smith could show that riding the yield curve provides a total return that is *most likely*:

A lower than the return on a maturity-matching strategy.

B equal to the return on a maturity-matching strategy.

C higher than the return on a maturity-matching strategy.

39 In presenting Investment 2, Smith should show a total return *closest* to:

A 4.31%.

B 5.42%.

C 6.53%.

40 The bond in Investment 3 is *most likely* trading at a price of:

A 100.97.

B 101.54.

C 104.09.

41 The *most* appropriate response to Mathews question regarding a spread measure is the:

A Z-spread.

B Treasury–Eurodollar (TED) spread.

C Libor–OIS (overnight indexed swap) spread.

The following information relates to Questions 42–48

Rowan Madison is a junior analyst at Cardinal Capital. Sage Winter, a senior portfolio manager and Madison's supervisor, meets with Madison to discuss interest rates and review two bond positions in the firm's fixed-income portfolio.

Winter begins the meeting by asking Madison to state her views on the term structure of interest rates. Madison responds:

> "Yields are a reflection of expected spot rates and risk premiums. Investors demand risk premiums for holding long-term bonds, and these risk premiums increase with maturity."

Winter next asks Madison to describe features of equilibrium and arbitrage-free term structure models. Madison responds by making the following statements:

Statement 1 "Equilibrium term structure models are factor models that use the observed market prices of a reference set of financial instruments, assumed to be correctly priced, to model the market yield curve."

Statement 2 "In contrast, arbitrage-free term structure models seek to describe the dynamics of the term structure by using fundamental economic variables that are assumed to affect interest rates."

Winter asks Madison about her preferences concerning term structure models. Madison states:

> "I prefer arbitrage-free models. Even though equilibrium models require fewer parameters to be estimated relative to arbitrage-free models, arbitrage-free models allow for time-varying parameters. In general, this allowance leads to arbitrage-free models being able to model the market yield curve more precisely than equilibrium models."

Winter tells Madison that, based on recent changes in spreads, she is concerned about a perceived increase in counterparty risk in the economy and its effect on the portfolio. Madison asks Winter:

> "Which spread measure should we use to assess changes in counterparty risk in the economy?"

Winter is also worried about the effect of yield volatility on the portfolio. She asks Madison to identify the economic factors that affect short-term and long-term rate volatility. Madison responds:

> "Short-term rate volatility is mostly linked to uncertainty regarding monetary policy, whereas long-term rate volatility is mostly linked to uncertainty regarding the real economy and inflation."

Finally, Winter asks Madison to analyze the interest rate risk portfolio positions in a 5-year and a 20-year bond. Winter requests that the analysis be based on level, slope, and curvature as term structure factors. Madison presents her analysis in Exhibit 1.

Exhibit 1 Three-Factor Model of Term Structure

	Time to Maturity (years)	
Factor	**5**	**20**
Level	–0.4352%	–0.5128%
Steepness	–0.0515%	–0.3015%
Curvature	0.3963%	0.5227%

Note: Entries indicate how yields would change for a one standard deviation increase in a factor.

Winter asks Madison to perform two analyses:

Analysis 1: Calculate the expected change in yield on the 20-year bond resulting from a two standard deviation increase in the steepness factor.

Analysis 2: Calculate the expected change in yield on the five-year bond resulting from a one standard deviation decrease in the level factor and a one standard deviation decrease in the curvature factor.

42 Madison's views on the term structure of interest rates are *most* consistent with the:

A local expectations theory.

B segmented markets theory.

C liquidity preference theory.

43 Which of Madison's statement(s) regarding equilibrium and arbitrage-free term structure models is *incorrect*?

A Statement 1 only

B Statement 2 only

C Both Statement 1 and Statement 2

44 Is Madison correct in describing key differences in equilibrium and arbitrage-free models as they relate to the number of parameters and model accuracy?

A Yes.

B No, she is incorrect about which type of model requires fewer parameter estimates.

C No, she is incorrect about which type of model is more precise at modeling market yield curves.

45 The *most appropriate* response to Madison's question regarding the spread measure is the:

A Z-spread.

B Treasury–Eurodollar (TED) spread.

C Libor–OIS (overnight indexed swap) spread.

46 Is Madison's response regarding the factors that affect short-term and long-term rate volatility correct?

A Yes.

B No, she is incorrect regarding factors linked to long-term rate volatility.

C No, she is incorrect regarding factors linked to short-term rate volatility.

47 Based on Exhibit 1, the results of Analysis 1 should show the yield on the 20-year bond decreasing by:

A 0.3015%.

B 0.6030%.

C 0.8946%.

48 Based on Exhibit 1, the results of Analysis 2 should show the yield on the five-year bond:

A decreasing by 0.8315%.

B decreasing by 0.0389%.

C increasing by 0.0389%.

The following information relates to Questions 49–57

Liz Tyo is a fund manager for an actively managed global fixed-income fund that buys bonds issued in Countries A, B, and C. She and her assistant are preparing the quarterly markets update. Tyo begins the meeting by distributing the daily rates sheet, which includes the current government spot rates for Countries A, B, and C as shown in Exhibit 1.

Exhibit 1 Today's Government Spot Rates

Maturity	Country A	Country B	Country C
One year	0.40%	–0.22%	14.00%
Two years	0.70	–0.20	12.40
Three years	1.00	–0.12	11.80
Four years	1.30	–0.02	11.00
Five years	1.50	0.13	10.70

Tyo asks her assistant how these spot rates were obtained. The assistant replies, "Spot rates are determined through the process of bootstrapping. It entails backward substitution using par yields to solve for zero-coupon rates one by one, in order from latest to earliest maturities."

Tyo then provides a review of the fund's performance during the last year and comments, "The choice of an appropriate benchmark depends on the country's characteristics. For example, although Countries A and B have both an active government bond market and a swap market, Country C's private sector is much bigger than its public sector, and its government bond market lacks liquidity."

Tyo further points out, "The fund's results were mixed; returns did not benefit from taking on additional risk. We are especially monitoring the riskiness of the corporate bond holdings. For example, our largest holdings consist of three four-year corporate bonds (Bonds 1, 2, and 3) with identical maturities, coupon rates, and other contract terms. These bonds have *Z*-spreads of 0.55%, 1.52%, and 1.76%, respectively."

Tyo continues, "We also look at risk in terms of the swap spread. We considered historical three-year swap spreads for Country B, which reflect that market's credit and liquidity risks, at three different points in time." Tyo provides the information in Exhibit 2.

Exhibit 2 Selected Historical Three-Year Rates for Country B

Period	Government Bond Yield (%)	Fixed-for-Floating Libor Swap (%)
1 Month ago	–0.10	0.16
6 Months ago	–0.08	0.01
12 Months ago	–0.07	0.71

Tyo then suggests that the firm was able to add return by riding the yield curve. The fund plans to continue to use this strategy but only in markets with an attractive yield curve for this strategy.

She moves on to present her market views on the respective yield curves for a five-year investment horizon.

Country A: "The government yield curve has changed little in terms of its level and shape during the last few years, and I expect this trend to continue. We assume that future spot rates reflect the current forward curve for all maturities."

Country B: "Because of recent economic trends, I expect a reversal in the slope of the current yield curve. We assume that future spot rates will be higher than current forward rates for all maturities."

Country C: "To improve liquidity, Country C's central bank is expected to intervene, leading to a reversal in the slope of the existing yield curve. We assume that future spot rates will be lower than today's forward rates for all maturities."

Tyo's assistant asks, "Assuming investors require liquidity premiums, how can a yield curve slope downward? What does this imply about forward rates?"

Tyo answers, "Even if investors require compensation for holding longer-term bonds, the yield curve can slope downward—for example, if there is an expectation of severe deflation. Regarding forward rates, it can be helpful to understand yield curve dynamics by calculating implied forward rates. To see what I mean, we can use Exhibit 1 to calculate the forward rate for a two-year Country C loan beginning in three years."

49 Did Tyo's assistant accurately describe the process of bootstrapping?

A Yes.

B No, with respect to par yields.

C No, with respect to backward substitution.

50 The swap curve is a better benchmark than the government spot curve for:

A Country A.

B Country B.

C Country C.

51 Based on the given *Z*-spreads for Bonds 1, 2, and 3, which bond has the greatest credit and liquidity risk?

A Bond 1

B Bond 2

C Bond 3

52 Based on Exhibit 2, the implied credit and liquidity risks as indicated by the historical three-year swap spreads for Country B were the lowest:

A 1 month ago.

B 6 months ago.

C 12 months ago.

53 Based on Exhibit 1 and Tyo's expectations, which country's term structure is currently best for traders seeking to ride the yield curve?

A Country A

B Country B

C Country C

54 Based on Exhibit 1 and assuming Tyo's market views on yield curve changes are realized, the forward curve of which country will lie below its spot curve?

A Country A

B Country B

C Country C

55 Based on Exhibit 1 and Tyo's expectations for the yield curves, Tyo *most likely* perceives the bonds of which country to be fairly valued?

A Country A

B Country B

C Country C

56 With respect to their discussion of yield curves, Tyo and her assistant are *most likely* discussing which term structure theory?

A Pure expectations theory

B Local expectations theory

C Liquidity preference theory

57 Tyo's assistant should calculate a forward rate *closest* to:

A 9.07%.

B 9.58%.

C 9.97%.

SOLUTIONS

1 Three forward rates can be calculated from the one-, two- and three-year spot rates. The rate on a one-year loan that begins at the end of Year 1 can be calculated using the one- and two-year spot rates; in the following equation one would solve for $f(1,1)$:

$$[1 + r(2)]^2 = [1 + r(1)]^1[1 + f(1,1)]^1$$

The rate on a one-year loan that starts at the end of Year 2 can be calculated from the two- and three-year spot rates; in the following equation one would solve for $f(2,1)$:

$$[1 + r(3)]^3 = [1 + r(2)]^2[1 + f(2,1)]^1$$

Additionally, the rate on a two-year loan that begins at the end of Year 1 can be computed from the one- and three-year spot rates; in the following equation one would solve for $f(1,2)$:

$$[1 + r(3)]^3 = [1 + r(1)]^1[1 + f(1,2)]^2$$

2 For the two-year forward rate one year from now of 2%, the two interpretations are as follows:

- 2% is the rate that will make an investor indifferent between buying a three-year zero-coupon bond or investing in a one-year zero-coupon bond and when it matures reinvesting in a zero-coupon bond that matures in two years.
- 2% is the rate that can be locked in today by buying a three-year zero-coupon bond rather than investing in a one-year zero-coupon bond and when it matures reinvesting in a zero-coupon bond that matures in two years.

3 A flat yield curve implies that all spot interest rates are the same. When the spot rate is the same for every maturity, successive applications of the forward rate model will show all the forward rates will also be the same and equal to the spot rate.

4 **A** The yield to maturity of a coupon bond is the expected rate of return on a bond if the bond is held to maturity, there is no default, and the bond and all coupons are reinvested at the original yield to maturity.

B Yes, it is possible. For example, if reinvestment rates for the future coupons are lower than the initial yield to maturity, a bond holder may experience lower realized returns.

5 If forward rates are higher than expected future spot rates the market price of the bond will be lower than the intrinsic value. This is because, everything else held constant, the market is currently discounting the bonds cash flows at a higher rate than the investor's expected future spot rates. The investor can capitalize on this by purchasing the undervalued bond. If expected future spot rates are realized, then bond prices should rise, thus generating gains for the investor.

6 The strategy of riding the yield curve is one in which a bond trader attempts to generate a total return over a given investment horizon that exceeds the return to bond with maturity matched to the horizon. The strategy involves buying a bond with maturity more distant than the investment horizon. Assuming an upward sloping yield curve, if the yield curve does not change level or shape, as

the bond approaches maturity (or rolls down the yield curve) it will be priced at successively lower yields. So as long as the bond is held for a period less than maturity, it should generate higher returns because of price gains.

7 Some countries do not have active government bond markets with trading at all maturities. For those countries without a liquid government bond market but with an active swap market, there are typically more points available to construct a swap curve than a government bond yield curve. For those markets, the swap curve may be a superior benchmark.

8 The Z-spread is the constant basis point spread added to the default-free spot curve to correctly price a risky bond. A Z-spread of 100bps for a particular bond would imply that adding a fixed spread of 100bps to the points along the spot yield curve will correctly price the bond. A higher Z-spread would imply a riskier bond.

9 The TED spread is the difference between a Libor rate and the US T-Bill rate of matching maturity. It is an indicator of perceived credit risk in the general economy. I particular, because sovereign debt instruments are typically the benchmark for the lowest default risk instruments in a given market, and loans between banks (often at Libor) have some counterparty risk, the TED spread is considered to at least in part reflect default (or counterparty) risk in the banking sector.

10 The local expectations theory asserts that the total return over a one-month horizon for a five-year zero-coupon bond would be the same as for a two-year zero-coupon bond.

11 Both theories attempt to explain the shape of any yield curve in terms of supply and demand for bonds. In segmented market theory, bond market participants are limited to purchase of maturities that match the timing of their liabilities. In the preferred habitat theory, participants have a preferred maturity for asset purchases, but may deviate from it if they feel returns in other maturities offer sufficient compensation for leaving their preferred maturity segment.

12 A Studies have shown that there have been three factors that affect Treasury returns: (1) changes in the level of the yield curve, (2) changes in the slope of the yield curve, and (3) changes in the curvature of the yield curve. Changes in the level refer to upward or downward shifts in the yield curve. For example, an upward shift in the yield curve is likely to result in lower returns across all maturities. Changes in the slope of the yield curve relate to the steepness of the yield curve. Thus, if the yield curve steepens it is likely to result in higher returns for short maturity bonds and lower returns for long maturity bonds. An example of a change in the curvature of the yield curve is a situation where rates fall at the short and long end of the yield curve while rising for intermediate maturities. In this situation returns on short and long maturities are likely to rise to rise while declining for intermediate maturity bonds.

B Empirically, the most important factor is the change in the level of interest rates.

C Key rate durations and a measure based on sensitivities to level, slope, and curvature movements can address shaping risk, but effective duration cannot.

13 C is correct. There is no spot rate information to provide rates for a loan that terminates in five years. That is $f(2,3)$ is calculated as follows:

$$f(2,3) = \sqrt[3]{\frac{\left[1 + r(5)\right]^5}{\left[1 + r(2)\right]^2}} - 1$$

The equation above indicates that in order to calculate the rate for a three-year loan beginning at the end of two years you need the five year spot rate $r(5)$ and the two-year spot rate $r(2)$. However $r(5)$ is not provided.

14 A is correct. The forward rate for a one-year loan beginning in one-year $f(1,1)$ is $1.04^2/1.03 - 1 = 5\%$. The rate for a one-year loan beginning in two-years $f(2,1)$ is $1.05^3/1.04^2 - 1 = 7\%$. This confirms that an upward sloping yield curve is consistent with an upward sloping forward curve.

15 C is correct. If one-period forward rates are decreasing with maturity then the forward curve is downward sloping. This turn implies a downward sloping yield curve where longer term spot rates $r(T + T^*)$ are less than shorter term spot rates $r(T)$.

16 C is correct. From the forward rate model, we have

$$[1 + r(2)]^2 = [1 + r(1)]^1[1 + f(1,1)]^1$$

Using the one- and two-year spot rates, we have

$$(1 + .05)^2 = (1 + .04)^1[1 + f(1,1)]^1, \text{ so } \frac{(1 + .05)^2}{(1 + .04)^1} - 1 = f(1,1) = 6.010\%$$

17 C is correct. From the forward rate model,

$$[1 + r(3)]^3 = [1 + r(1)]^1[1 + f(1,2)]^2$$

Using the one and three-year spot rates, we find

$$(1 + 0.06)^3 = (1 + 0.04)^1[1 + f(1,2)]^2, \text{ so } \sqrt{\frac{(1 + 0.06)^3}{(1 + 0.04)^1}} - 1 = f(1,2) = 7.014\%$$

18 C is correct. From the forward rate model,

$$[1 + r(3)]^3 = [1 + r(2)]^2[1 + f(2,1)]^1$$

Using the two and three-year spot rates, we find

$$(1 + 0.06)^3 = (1 + 0.05)^2[1 + f(2,1)]^1, \text{ so } \frac{(1 + 0.06)^3}{(1 + 0.05)^2} - 1 = f(2,1) = 8.029\%$$

19 A is correct. We can convert spot rates to spot prices to find $P(3) = \frac{1}{(1.06)^3} =$ 0.8396. The forward pricing model can be used to find the price of the five-year zero as $P(T^* + T) = P(T^*)F(T^*,T)$, so $P(5) = P(3)F(3,2) = 0.8396 \times 0.8479 = 0.7119$.

20 B is correct. Applying the forward rate model, we find

$$[1 + r(3)]^3 = [1 + r(1)]^1[1 + f(1,1)]^1[1 + f(2,1)]^1$$

So $[1 + r(3)]^3 = (1 + 0.04)^1(1 + 0.06)^1(1 + 0.08)^1$, $\sqrt[3]{1.1906} - 1 = r(3) = 5.987\%$.

21 B is correct. We can convert spot rates to spot prices and use the forward pricing model, so have $P(1) = \frac{1}{(1.05)^1} = 0.9524$. The forward pricing model is $P(T^* + T) = P(T^*)F(T^*,T)$ so $P(2) = P(1)F(1,1) = 0.9524 \times 0.9346 = 0.8901$.

22 A is correct. The swap rate is the interest rate for the fixed-rate leg of an interest rate swap.

23 A is correct. The swap spread = 1.00% – 0.63% = 0.37% or 37 bps.

24 C is correct. The fixed leg of the five-year fixed-for-floating swap will be equal to the five-year Treasury rate plus the swap spread: 2% + 0.5% = 2.5%.

25 A is correct. The TED spread is the difference between the three-month Libor rate and the three-month Treasury bill rate. If the T-bill rate falls and Libor does not change, the TED spread will increase.

26 A is correct. The Z-spread is the single rate which, when added to the rates of the spot yield curve, will provide the correct discount rates to price a particular risky bond.

27 A is correct. The 200bps Z-spread can be added to the 5% rates from the yield curve to price the bond. The resulting 7% discount rate will be the same for all of the bond's cash-flows, since the yield curve is flat. A 7% coupon bond yielding 7% will be priced at par.

28 B is correct. The higher Z-spread for Bond B implies it is riskier than Bond A. The higher discount rate will make the price of Bond B lower than Bond A.

29 A is correct. The Ho–Lee model is arbitrage-free and can be calibrated to closely match the observed term structure.

30 B is correct. The five-year spot rate is determined by using forward substitution and using the known values of the one-year, two-year, three-year, and four-year spot rates as follows:

$$1 = \frac{0.0437}{(1.025)} + \frac{0.0437}{(1.030)^2} + \frac{0.0437}{(1.035)^3} + \frac{0.0437}{(1.040)^4} + \frac{1 + 0.0437}{\left[1 + r(5)\right]^5}$$

$$r(5) = \sqrt[5]{\frac{1.0437}{0.8394}} - 1 = 4.453\%$$

31 B is correct. The spot rates imply an upward-sloping yield curve, $r(3) > r(2) > r(1)$. Because nominal yields incorporate a premium for expected inflation, an upward-sloping yield curve is generally interpreted as reflecting a market expectation of increasing, or at least level, future inflation (associated with relatively strong economic growth).

32 C is correct. A one-year loan beginning in three years, or $f(3,1)$, is calculated as follows:

$$\left[1 + r(3+1)\right]^{(3+1)} = \left[1 + r(3)\right]^3\left[1 + f(3,1)\right]^1$$

$$\left[1.040\right]^4 = \left[1.035\right]^3\left[1 + f(3,1)\right]^1$$

$$f(3,1) = \frac{(1.04)^4}{(1.035)^3} - 1 = 5.514\%$$

33 C is correct. Exhibit 1 provides five years of par rates, from which the spot rates for $r(1)$, $r(2)$, $r(3)$, $r(4)$, and $r(5)$ can be derived. Thus the forward rate $f(1,4)$ can be calculated as follows:

$$f(1,4) = \sqrt[4]{\frac{[1 + r(5)]^5}{[1 + r(1)]}} - 1$$

34 C is correct. The yield to maturity, $y(3)$, of Bond Z should be a weighted average of the spot rates used in the valuation of the bond. Because the bond's largest cash flow occurs in Year 3, $r(3)$ will have a greater weight than $r(1)$ and $r(2)$ in determining $y(3)$.

Using the spot rates:

$$\text{Price} = \frac{\$60}{(1.025)^1} + \frac{\$60}{(1.030)^2} + \frac{\$1{,}060}{(1.035)^3} = \$1{,}071.16$$

Using the yield to maturity:

$$\text{Price} = \frac{\$60}{[1 + y(3)]^1} + \frac{\$60}{[1 + y(3)]^2} + \frac{\$1{,}060}{[1 + y(3)]^3} = \$1{,}071.16$$

Using a calculator, the compute result is $y(3) = 3.46\%$, which is closest to the three-year spot rate of 3.50%.

35 A is correct. Alexander projects that the spot curve two years from today will be below the current forward curve, which implies that her expected future spot rates beyond two years will be lower than the quoted forward rates. Alexander would perceive Bond Z to be undervalued in the sense that the market is effectively discounting the bond's payments at a higher rate than she would and the bond's market price is below her estimate of intrinsic value.

36 B is correct. Nguyen's strategy is to ride the yield curve, which is appropriate when the yield curve is upward sloping. The yield curve implied by Exhibit 1 is upward sloping, which implies that the three-year forward curve is above the current spot curve. When the yield curve slopes upward, as a bond approaches maturity or "rolls down the yield curve," the bond is valued at successively lower yields and higher prices.

37 B is correct. The forward pricing model is based on the no-arbitrage principle and is used to calculate a bond's forward price based on the spot yield curve. The spot curve is constructed by using annualized rates from option-free and default risk–free zero-coupon bonds.

Equation 2: $P(T^* + T) = P(T^*)F(T^*,T)$; we need to solve for $F(1,1)$.

$P(1) = 1/(1 + 0.0225)^1$ and $P(2) = 1/(1 + 0.0270)^2$,

$F(1,1) = P(2)/P(1) = 0.9481/0.9780 = 0.9694$.

38 C is correct. When the spot curve is upward sloping and its level and shape are expected to remain constant over an investment horizon (Shire Gate Advisers' view), buying bonds with a maturity longer than the investment horizon (i.e., riding the yield curve) will provide a total return greater than the return on a maturity-matching strategy.

39 C is correct. The swap spread is a common way to indicate credit spreads in a market. The four-year swap rate (fixed leg of an interest rate swap) can be used as an indication of the four-year corporate yield. Riding the yield curve by purchasing a four-year zero-coupon bond with a yield of 4.75% {i.e., 4.05% + 0.70%, $[P_4 = 100/(1 + 0.0475)^4 = 83.058]$} and then selling it when it becomes a two-year zero-coupon bond with a yield of 3.00% {i.e., 2.70% + 0.30%, $[P_2 = 100/(1 + 0.0300)^2 = 94.260]$} produces an annual return of 6.53%: $(94.260/83.058)^{0.5} - 1.0 = 0.0653$.

40 B is correct. The Z-spread is the constant basis point spread that is added to the default-free spot curve to price a risky bond. A Z-spread of 65 bps for a particular bond would imply adding a fixed spread of 65 bps to maturities along the spot curve to correctly price the bond. Therefore, for the two-year bond, $r(1)$ = 2.90% (i.e., 2.25% + 0.65%), $r(2)$ = 3.35% (i.e., 2.70% + 0.65%), and the price of the bond with an annual coupon of 4.15% is as follows:

$$P = 4.15/(1 + 0.029)^1 + 4.15/(1 + 0.0335)^2 + 100/(1 + 0.0335)^2,$$

$$P = 101.54.$$

41 C is correct. The Libor–OIS spread is considered an indicator of the risk and liquidity of money market securities. This spread measures the difference between Libor and the OIS rate.

42 C is correct. Liquidity preference theory asserts that investors demand a risk premium, in the form of a liquidity premium, to compensate them for the added interest rate risk they face when buying long-maturity bonds. The theory also states that the liquidity premium increases with maturity.

43 C is correct. Both statements are incorrect because Madison incorrectly describes both types of models. Equilibrium term structure models are factor models that seek to describe the dynamics of the term structure by using fundamental economic variables that are assumed to affect interest rates. Arbitrage-free term structure models use observed market prices of a reference set of financial instruments, assumed to be correctly priced, to model the market yield curve.

44 A is correct. Consistent with Madison's statement, equilibrium term structure models require fewer parameters to be estimated relative to arbitrage-free models, and arbitrage-free models allow for time-varying parameters. Consequently, arbitrage-free models can model the market yield curve more precisely than equilibrium models.

45 B is correct. The TED spread, calculated as the difference between Libor and the yield on a T-bill of matching maturity, is an indicator of perceived credit risk in the general economy. An increase (decrease) in the TED spread signals that lenders believe the risk of default on interbank loans is increasing (decreasing). Therefore, the TED spread can be thought of as a measure of counterparty risk.

46 A is correct. Madison's response is correct; research indicates that short-term rate volatility is mostly linked to uncertainty regarding monetary policy, whereas long-term rate volatility is mostly linked to uncertainty regarding the real economy and inflation.

47 B is correct. Because the factors in Exhibit 1 have been standardized to have unit standard deviations, a two standard deviation increase in the steepness factor will lead to the yield on the 20-year bond decreasing by 0.6030%, calculated as follows:

$$\text{Change in 20-year bond yield} = -0.3015\% \times 2 = -0.6030\%.$$

48 C is correct. Because the factors in Exhibit 1 have been standardized to have unit standard deviations, a one standard deviation decrease in both the level factor and the curvature factor will lead to the yield on the five-year bond increasing by 0.0389%, calculated as follows:

Change in five-year bond yield = 0.4352% – 0.3963% = 0.0389%.

49 C is correct. The assistant states that bootstrapping entails *backward* substitution using par yields to solve for zero-coupon rates one by one, in order from latest to earliest maturities. Bootstrapping entails *forward* substitution, however, using par yields to solve for zero-coupon rates one by one, in order from earliest to latest maturities.

50 C is correct. Country C's private sector is much bigger than the public sector, and the government bond market in Country C currently lacks liquidity. Under such circumstances, the swap curve is a more relevant benchmark for interest rates.

51 C is correct. Although swap spreads provide a convenient way to measure risk, a more accurate measure of credit and liquidity risk is called the zero-spread (*Z*-spread). It is the constant spread that, added to the implied spot yield curve, makes the discounted cash flows of a bond equal to its current market price. Bonds 1, 2, and 3 are otherwise similar but have *Z*-spreads of 0.55%, 1.52%, and 1.76%, respectively. Bond 3 has the highest *Z*-spread, implying that this bond has the greatest credit and liquidity risk.

52 B is correct. The historical three-year swap spread for Country B was the lowest six months ago. Swap spread is defined as the spread paid by the fixed-rate payer of an interest rate swap over the rate of the "on the run" (most recently issued) government bond security with the same maturity as the swap. The lower (higher) the swap spread, the lower (higher) the return that investors require for credit and/or liquidity risks.

The fixed rate of the three-year fixed-for-floating Libor swap was 0.01% six months ago, and the three-year government bond yield was –0.08% six months ago. Thus the swap spread six months ago was 0.01% – (–0.08%) = 0.09%.

One month ago, the fixed rate of the three-year fixed-for-floating Libor swap was 0.16%, and the three-year government bond yield was –0.10%. Thus the swap spread one month ago was 0.16% – (–0.10%) = 0.26%.

Twelve months ago, the fixed rate of the three-year fixed-for-floating Libor swap was 0.71%, and the three-year government bond yield was –0.07%. Thus, the swap spread 12 months ago was 0.71% – (–0.07%) = 0.78%.

53 A is correct. Country A's yield curve is upward sloping—a condition for the strategy—and more so than Country B's.

54 B is correct. The yield curve for Country B is currently upward sloping, but Tyo expects a reversal in the slope of the current yield curve. This means she expects the resulting yield curve for Country B to slope downward, which implies that the resulting forward curve would lie below the spot yield curve. The forward curve lies below the spot curve in scenarios in which the spot curve is downward sloping; the forward curve lies above the spot curve in scenarios in which the spot curve is upward sloping.

A is incorrect because the yield curve for Country A is currently upward sloping and Tyo expects that the yield curve will maintain its shape and level. That expectation implies that the resulting forward curve would be above the spot yield curve.

C is incorrect because the yield curve for Country C is currently downward sloping and Tyo expects a reversal in the slope of the current yield curve. This means she expects the resulting yield curve for Country C to slope upward, which implies that the resulting forward curve would be above the spot yield curve.

55 A is correct. Tyo's projected spot curve assumes that future spot rates reflect, or will be equal to, the current forward rates for all respective maturities. This assumption implies that the bonds for Country A are fairly valued because the market is effectively discounting the bond's payments at spot rates that match those projected by Tyo.

B and C are incorrect because Tyo's projected spot curves for the two countries do not match the current forward rates for all respective maturities. In the case of Country B, she expects future spot rates to be higher (than the current forward rates that the market is using to discount the bond's payments). For Country C, she expects future spot rates to be lower (than the current forward rates). Hence, she perceives the Country B bond to be currently overvalued and the Country C bond to be undervalued.

56 C is correct. Liquidity preference theory suggests that liquidity premiums exist to compensate investors for the added interest rate risk that they face when lending long term and that these premiums increase with maturity. Tyo and her assistant are assuming that liquidity premiums exist.

57 A is correct. From the forward rate model, $f(3,2)$, is found as follows:

$$[1 + r(5)]^5 = [1 + r(3)]^3[1 + f(3,2)]^2$$

Using the three-year and five-year spot rates, we find

$$(1 + 0.107)^5 = (1 + 0.118)^3[1 + f(3,2)]^2, \text{ so}$$

$$\sqrt{\frac{(1 + 0.107)^5}{(1 + 0.118)^3}} - 1 = f(3,2) = 9.07\%$$

PRACTICE PROBLEMS

The following information relates to Questions 1–6

Katrina Black, portfolio manager at Coral Bond Management, Ltd., is conducting a training session with Alex Sun, a junior analyst in the fixed income department. Black wants to explain to Sun the arbitrage-free valuation framework used by the firm. Black presents Sun with Exhibit 1, showing a fictitious bond being traded on three exchanges, and asks Sun to identify the arbitrage opportunity of the bond. Sun agrees to ignore transaction costs in his analysis.

Exhibit 1 Three-Year, €100 par, 3.00% Coupon, Annual Pay Option-Free Bond

	Eurex	NYSE Euronext	Frankfurt
Price	€103.7956	€103.7815	€103.7565

Black shows Sun some exhibits that were part of a recent presentation. Exhibit 3 presents most of the data of a binomial lognormal interest rate tree fit to the yield curve shown in Exhibit 2. Exhibit 4 presents most of the data of the implied values for a four-year, option-free, annual pay bond with a 2.5% coupon based on the information in Exhibit 3.

Exhibit 2 Yield to Maturity Par Rates for One-, Two-, and Three-Year Annual Pay Option-Free Bonds

One-year	Two-year	Three-year
1.25%	1.50%	1.70%

Exhibit 3 Binomial Interest Rate Tree Fit to the Yield Curve (Volatility = 10%)

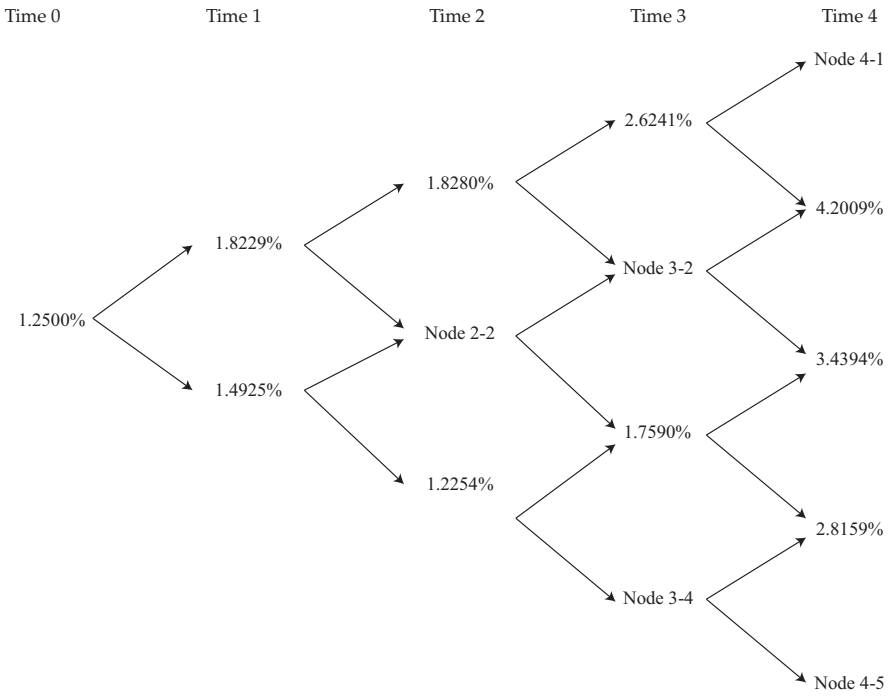
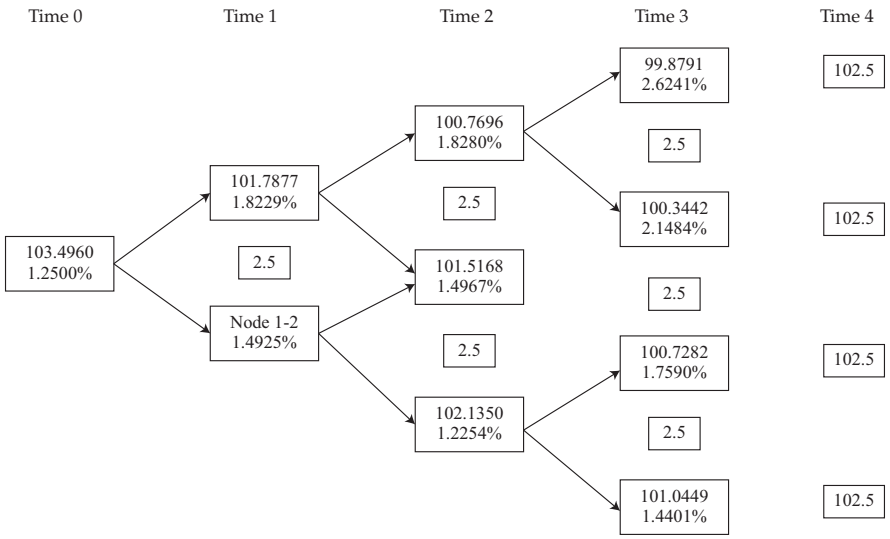


Exhibit 4 Implied Values (in Euros) for a 2.5%, Four-Year, Option-Free, Annual Pay Bond Based on Exhibit 3



Black asks about the missing data in Exhibits 3 and 4 and directs Sun to complete the following tasks related to those exhibits:

Task 1	Test that the binomial interest tree has been properly calibrated to be arbitrage-free.
Task 2	Develop a spreadsheet model to calculate pathwise valuations. To test the accuracy of the spreadsheet, use the data in Exhibit 3 and calculate the value of the bond if it takes a path of lowest rates in Year 1 and Year 2 and the second lowest rate in Year 3.
Task 3	Identify a type of bond where the Monte Carlo calibration method should be used in place of the binomial interest rate method.
Task 4	Update Exhibit 3 to reflect the current volatility, which is now 15%.

1 Based on Exhibit 1, the *best* action that an investor should take to profit from the arbitrage opportunity is to:

A buy on Frankfurt, sell on Eurex.

B buy on NYSE Euronext, sell on Eurex.

C buy on Frankfurt, sell on NYSE Euronext.

2 Based on Exhibits 1 and 2, the exchange that reflects the arbitrage-free price of the bond is:

A Eurex.

B Frankfurt.

C NYSE Euronext.

3 Which of the following statements about the missing data in Exhibit 3 is correct?

A Node 3–2 can be derived from Node 2–2.

B Node 4–1 should be equal to Node 4–5 multiplied by $e^{0.4}$.

C Node 2–2 approximates the implied one-year forward rate two years from now.

4 Based on the information in Exhibits 3 and 4, the bond price in euros at Node 1–2 in Exhibit 4 is *closest* to:

A 102.7917.

B 104.8640.

C 105.2917.

5 A benefit of performing Task 1 is that it:

A enables the model to price bonds with embedded options.

B identifies benchmark bonds that have been mispriced by the market.

C allows investors to realize arbitrage profits through stripping and reconstitution.

6 If the assumed volatility is changed as Black requested in Task 4, the forward rates shown in Exhibit 3 will *most likely*:

A spread out.

B remain unchanged.

C converge to the spot rates.

The following information relates to Questions 7–10

Betty Tatton is a fixed income analyst with the hedge fund Sailboat Asset Management (SAM). SAM invests in a variety of global fixed-income strategies, including fixed-income arbitrage. Tatton is responsible for pricing individual investments and analyzing market data to assess the opportunity for arbitrage. She uses two methods to value bonds:

Method 1 Discount each year's cash flow separately using the appropriate interest rate curve.

Method 2 Build and use a binomial interest rate tree.

Tatton compiles pricing data for a list of annual pay bonds (Exhibit 1). Each of the bonds will mature in two years, and Tatton considers the bonds as being risk-free; both the one-year and two-year benchmark spot rates are 2%. Tatton calculates the arbitrage-free prices and identifies an arbitrage opportunity to recommend to her team.

Exhibit 1 Market Data for Selected Bonds

Asset	Coupon	Market Price
Bond A	1%	98.0584
Bond B	3%	100.9641
Bond C	5%	105.8247

Next, Tatton uses the benchmark yield curve provided in Exhibit 2 to consider arbitrage opportunities of both option-free corporate bonds and corporate bonds with embedded options. The benchmark bonds in Exhibit 2 pay coupons annually, and the bonds are priced at par.

Exhibit 2 Benchmark Par Curve

Maturity (years)	Yield to Maturity (YTM)
1	3.0%
2	4.0%
3	5.0%

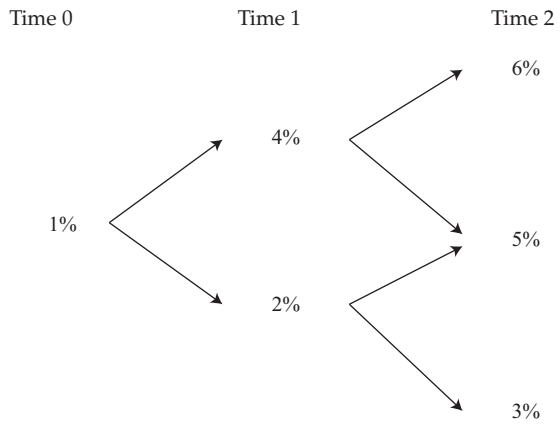
Tatton then identifies three mispriced three-year annual-pay bonds and compiles data on the bonds (see Exhibit 3).

Exhibit 3 Market Data of Annual-Pay Corporate Bonds

Company	Coupon	Market Price	Yield	Embedded Option?
Hutto-Barkley Inc.	3%	94.9984	5.6%	No
Luna y Estrellas Intl.	0%	88.8996	4.0%	Yes
Peaton Scorpio Motors	0%	83.9619	6.0%	No

Lastly, Tatton identifies two mispriced Swiss bonds, Bond X, a three-year bond, and Bond Y, a five-year bond. Both are annual-pay bonds with a coupon rate of 6%. To calculate the bonds' values, Tatton devises the first three years of the interest rate lognormal tree presented in Exhibit 4 using historical interest rate volatility data. Tatton considers how this data would change if implied volatility, which is higher than historical volatility, were used instead.

Exhibit 4 Interest Rate Tree; Forward Rates Based on Swiss Market



7 Based on Exhibit 1, which of the following bonds *most likely* includes an arbitrage opportunity?

A Bond A

B Bond B

C Bond C

8 Based on Exhibits 2 and 3 and using Method 1, the amount (in absolute terms) by which the Hutto-Barkley corporate bond is mispriced is *closest* to:

A 0.3368 per 100 of par value.

B 0.4682 per 100 of par value.

C 0.5156 per 100 of par value.

9 Method 1 would *most likely* **not** be an appropriate valuation technique for the bond issued by:

A Hutto-Barkley Inc.

B Luna y Estrellas Intl.

C Peaton Scorpio Motors.

10 Based on Exhibit 4 and using Method 2, the correct price for Bond X is *closest* to:

A 97.2998.

B 109.0085.

C 115.0085.

The following information relates to Questions 11–18

Meredith Alvarez is a junior fixed-income analyst with Canzim Asset Management. Her supervisor, Stephanie Hartson, asks Alvarez to review the asset price and payoff data shown in Exhibit 1 to determine whether an arbitrage opportunity exists.

Exhibit 1 Price and Payoffs for Two Risk-Free Assets

Asset	Price Today	Payoff in One Year
Asset A	$500	$525
Asset B	$1,000	$1,100

Hartson also shows Alvarez data for a bond that trades in three different markets in the same currency. These data appear in Exhibit 2.

Exhibit 2 2% Coupon, Five-Year Maturity, Annual Pay Bond

	New York	Hong Kong	Mumbai
Yield to Maturity	1.9%	2.3%	2.0%

Hartson asks Alvarez to value two bonds (Bond C and Bond D) using the binomial tree in Exhibit 3. Exhibit 4 presents selected data for both bonds.

Exhibit 3 Binomial Interest Rate Tree with Volatility = 25%

Time 0	Time 1	Time 2
		2.7183%
	2.8853%	
1.500%		1.6487%
	1.7500%	
		1.0000%

Exhibit 4 Selected Data on Annual Pay Bonds

Bond	Maturity	Coupon Rate
Bond C	2 years	2.5%
Bond D	3 years	3.0%

Hartson tells Alvarez that she and her peers have been debating various viewpoints regarding the conditions underlying binomial interest rate trees. The following statements were made in the course of the debate.

Statement 1 The only requirements needed to create a binomial interest rate tree are current benchmark interest rates and an assumption about interest rate volatility.

Statement 2 Potential interest rate volatility in a binomial interest rate tree can be estimated using historical interest rate volatility or observed market prices from interest rate derivatives.

Statement 3 A bond value derived from a binomial interest rate tree with a relatively high volatility assumption will be different from the value calculated by discounting the bond's cash flows using current spot rates.

Based on data in Exhibit 5, Hartson asks Alvarez to calibrate a binomial interest rate tree starting with the calculation of implied forward rates shown in Exhibit 6.

Exhibit 5 Selected Data for a Binomial Interest Rate Tree

Maturity	Par Rate	Spot Rate
1	2.5000%	2.5000%
2	3.5000%	3.5177%

Exhibit 6 Calibration of Binomial Interest Rate Tree with Volatility = 25%

Time 0	Time 1
	5.8365%
2.500%	
	Lower one-period forward rate

Hartson mentions pathwise valuations as another method to value bonds using a binomial interest rate tree. Using the binomial interest rate tree in Exhibit 3, Alvarez calculates the possible interest rate paths for Bond D shown in Exhibit 7.

Exhibit 7 Interest Rate Paths for Bond D

Path	Time 0	Time 1	Time 2
1	1.500%	2.8853%	2.7183%
2	1.500	2.8853	1.6487
3	1.500	1.7500	1.6487
4	1.500	1.7500	1.0000

Before leaving for the day, Hartson asks Alvarez about the value of using the Monte Carlo method to simulate a large number of potential interest rate paths to value a bond. Alvarez makes the following statements.

Statement 4 Increasing the number of paths increases the estimate's statistical accuracy.

Statement 5 The bond value derived from a Monte Carlo simulation will be closer to the bond's true fundamental value.

11 Based on Exhibit 1, Alvarez finds that an arbitrage opportunity is:

A not available.

B available based on the dominance principle.

C available based on the value additivity principle.

12 Based on the data in Exhibit 2, the *most* profitable arbitrage opportunity would be to buy the bond in:

A Mumbai and sell it in Hong Kong.

B Hong Kong and sell it in New York.

C New York and sell it in Hong Kong.

13 Based on Exhibits 3 and 4, the value of Bond C at the upper node at Time 1 is *closest* to:

A 97.1957.

B 99.6255.

C 102.1255.

14 Based on Exhibits 3 and 4, the price for Bond D is *closest* to:

A 97.4785.

B 103.3230.

C 106.3230.

15 Which of the various statements regarding binomial interest rate trees is correct?

A Statement 1

B Statement 2

C Statement 3

16 Based on Exhibits 5 and 6, the value of the lower one-period forward rate is *closest to*:

A 3.5122%.

B 3.5400%.

C 4.8037%.

17 Based on Exhibits 4 and 7, the present value of Bond D's cash flows following Path 2 is *closest* to:

A 97.0322.

B 102.8607.

C 105.8607.

18 Which of the statements regarding Monte Carlo simulation is correct?

A Only Statement 4 is correct.

B Only Statement 5 is correct.

C Both Statement 4 and Statement 5 are correct.

SOLUTIONS

1 A is correct. This is the same bond being sold at three different prices so an arbitrage opportunity exists by buying the bond from the exchange where it is priced lowest and immediately selling it on the exchange that has the highest price. Accordingly, an investor would maximize profit from the arbitrage opportunity by buying the bond on the Frankfurt exchange (which has the lowest price of €103.7565) and selling it on the Eurex exchange (which has the highest price of €103.7956) to generate a risk-free profit of €0.0391 (as mentioned, ignoring transaction costs) per €100 par.

B is incorrect because buying on NYSE Euronext and selling on Eurex would result in an €0.0141 profit per €100 par (€103.7956 – €103.7815 = €0.0141), which is not the maximum arbitrage profit available. A greater profit would be realized if the bond were purchased in Frankfurt and sold on Eurex.

C is incorrect because buying on Frankfurt and selling on NYSE Euronext would result in an €0.0250 profit per €100 par (€103.7815 – €103.7565 = €0.0250). A greater profit would be realized if the bond were purchased in Frankfurt and sold on Eurex.

2 C is correct. The bond from Exhibit 1 is selling for its calculated value on the NYSE Euronext exchange. The arbitrage-free value of a bond is the present value of its cash flows discounted by the spot rate for zero coupon bonds maturing on the same date as each cash flow. The value of this bond, 103.7815, is calculated as follows:

	Year 1	Year 2	Year 3	Total PV
Yield to maturity	1.2500%	1.500%	1.700%	
Spot rate[1]	1.2500%	1.5019%	1.7049%	
Cash flow	3.00	3.00	103.00	
Present value of payment[2]	2.9630	2.9119	97.9066	103.7815

	Eurex	NYSE Euronext	Frankfurt
Price	€103.7956	€103.7815	€103.7565
Mispricing (per 100 par value)	0.141	0	–0.025

Notes:

1 Spot rates calculated using bootstrapping; for example: Year 2 spot rate (z_2): $100 = 1.5/1.0125 + 101.5/(1+z_2)^2 = 0.015019$.

2 Present value calculated using the formula $PV = FV/(1+r)^n$, where n = number of years until cash flow, FV=cash flow amount, and r = spot rate.

A is incorrect because the price on the Eurex exchange, €103.7956, was calculated using the yield to maturity rate to discount the cash flows when the spot rates should have been used. C is incorrect because the price on the Frankfurt exchange, €103.7565, uses the Year 3 spot rate to discount all the cash flows.

3 C is correct. Because Node 2–2 is the middle node rate in Year 2, it will be close to the implied one-year forward rate two years from now (as derived from the spot curve). Node 4–1 should be equal to the product of Node 4–5 and $e^{0.8}$.

Lastly, Node 3–2 cannot be derived from Node 2–2; it can be derived from any other Year 3 node; for example, Node 3–2 can be derived from Node 3–4 (equal to the product of Node 3–4 and $e^{4\sigma}$).

4 A is correct. The value of a bond at a particular node, in this case Node 1–2, can be derived by determining the present value of the coupon payment and expected future bond values to the right of that node on the tree. In this case, those two nodes are the middle node in Year 2, equal to 101.5168, and the lower node in Year 2, equal to 102.1350. The coupon payment is 2.5. The bond value at Node 1–2 is calculated as follows:

$$\text{Value} = \frac{2.5 + \left(0.5 \times 101.5816 + 0.5 \times 102.1350\right)}{1.014925}$$
$$= 102.7917$$

5 A is correct. Calibrating a binomial interest rate tree to match a specific term structure is important because we can use the known valuation of a benchmark bond from the spot rate pricing to verify the accuracy of the rates shown in the binomial interest rate tree. Once its accuracy is confirmed, the interest rate tree can then be used to value bonds with embedded options. While discounting with spot rates will produce arbitrage-free valuations for option-free bonds, this spot rate method will not work for bonds with embedded options where expected future cash flows are interest-rate dependent (as rate changes impact the likelihood of options being exercised). The interest rate tree allows for the alternative paths that a bond with embedded options might take.

B is incorrect because calibration does not identify mispriced benchmark bonds. In fact, benchmark bonds are employed to prove the accuracy of the binomial interest rate tree, as they are assumed to be correctly priced by the market.

C is incorrect because the calibration of the binomial interest rate tree is designed to produce an arbitrage-free valuation approach and such an approach does not allow a market participant to realize arbitrage profits though stripping and reconstitution.

6 A is correct. Volatility is one of the two key assumptions required to estimate rates for the binomial interest rate tree. Increasing the volatility from 10% to 15% would cause the possible forward rates to spread out on the tree as it increases the exponent in the relationship multiple between nodes ($e^{x\sigma}$, where x = 2 times the number of nodes above the lowest node in a given year in the interest rate tree). Conversely, using a lower estimate of volatility would cause the forward rates to narrow or converge to the implied forward rates from the prevailing yield curve.

B is incorrect because volatility is a key assumption in the binomial interest rate tree model. Any change in volatility will cause a change in the implied forward rates.

C is incorrect because increasing the volatility from 10% to 15% causes the possible forward rates to spread out on the tree, not converge to the implied forward rates from the current yield curve. Rates will converge to the implied forward rates when lower estimates of volatility are assumed.

7 B is correct. Bond B's arbitrage-free price is calculated as follows:

$$\frac{3}{1.02} + \frac{103}{1.02^2} = 101.9416$$

which is higher than the bond's market price of 100.9641. Therefore, an arbitrage opportunity exists. Since the bond's value (100.9641) is less than the sum of the values of its discounted cash flows individually (101.9416), a trader would perceive an arbitrage opportunity and could buy the bond while selling claims to the individual cash flows (zeros), capturing the excess value. The arbitrage-free prices of Bond A and Bond C are equal to the market prices of the respective bonds, so there is no arbitrage opportunity for these two bonds:

$$\text{Bond A: } \frac{1}{1.02} + \frac{101}{1.02^2} = 98.0584$$

$$\text{Bond C: } \frac{5}{1.02} + \frac{105}{1.02^2} = 105.8247$$

8 C is correct. The first step in the solution is to find the correct spot rate (zero-coupon rates) for each year's cash flow. The benchmark bonds in Exhibit 2 are conveniently priced at par so the yields to maturity and the coupon rates on the bonds are the same. Because the one-year issue has only one cash flow remaining, the YTM equals the spot rate of 3% (or $z_1 = 3\%$). The spot rates for Year 2 (z_2) and Year 3 (z_3) are calculated as follows:

$$100 = \frac{4}{1.0300} + \frac{104}{(1 + z_2)^2}; z_2 = 4.02\%$$

$$100 = \frac{5}{1.0300} + \frac{5}{(1.0402)^2} + \frac{105}{(1 + z_3)^3}; z_3 = 5.07\%$$

The correct arbitrage-free price for the Hutto-Barkley Inc. bond is:

$$P_0 = \frac{3}{(1.0300)} + \frac{3}{(1.0402)^2} + \frac{103}{(1.0507)^3} = 94.4828$$

Therefore, the bond is mispriced by 94.9984 – 94.4828 = 0.5156 per 100 of par value.

A is incorrect because the correct spot rates are not calculated and instead the Hutto-Barkley Inc. bond is discounted using the respective YTM for each maturity. Therefore, this leads to an incorrect mispricing of 94.6616 – 94.9984 = –0.3368 per 100 of par value.

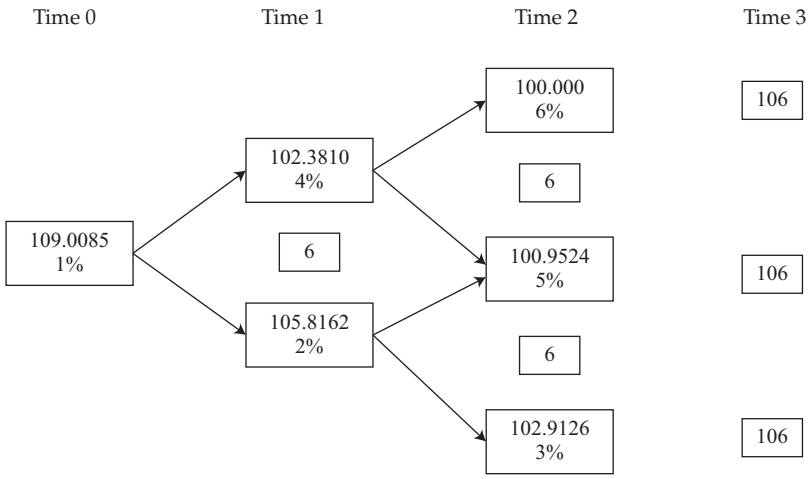
B is incorrect because the spot rates are derived using the coupon rate for Year 3 (maturity) instead of using each year's respective coupon rate to employ the bootstrap methodology. This leads to an incorrect mispricing of 94.5302 – 94.9984 = –0.4682 per 100 of par value.

9 B is correct. The Luna y Estrellas Intl. bond contains an embedded option. Method 1 will produce an arbitrage-free valuation for option-free bonds; however, for bonds with embedded options, changes in future interest rates impact the likelihood the option will be exercised and so impact future cash flows. Therefore, to develop a framework that values bonds with embedded options, interest rates must be allowed to take on different potential values in the future based on some assumed level of volatility (Method 2).

A and C are incorrect because the Hutto-Barkley Inc. bond and the Peaton Scorpio Motors bond are both option-free bonds and can be valued using either Method 1 or Method 2 to produce an arbitrage-free valuation.

10 B is correct. This is the binomial tree that obtains a bond value of 109.0085.

Valuing a 6%, Three-Year Bond



These are the calculations:

106/1.06 = 100.0000

106/1.05 = 100.9524

106/1.03 = 102.9126

$$\frac{6 + \left(0.5 \times 100.0000 + 0.5 \times 100.9524\right)}{1.04} = 102.3810$$

$$\frac{6 + \left(0.5 \times 100.9524 + 0.5 \times 102.9126\right)}{1.02} = 105.8162$$

$$\frac{6 + \left(0.5 \times 102.3810 + 0.5 \times 105.8162\right)}{1.01} = 109.0085$$

A is incorrect because the Time T coupon payment is subtracted from the value in each node calculation for Time T. C is incorrect because it assumes that a coupon is paid at Time 0.

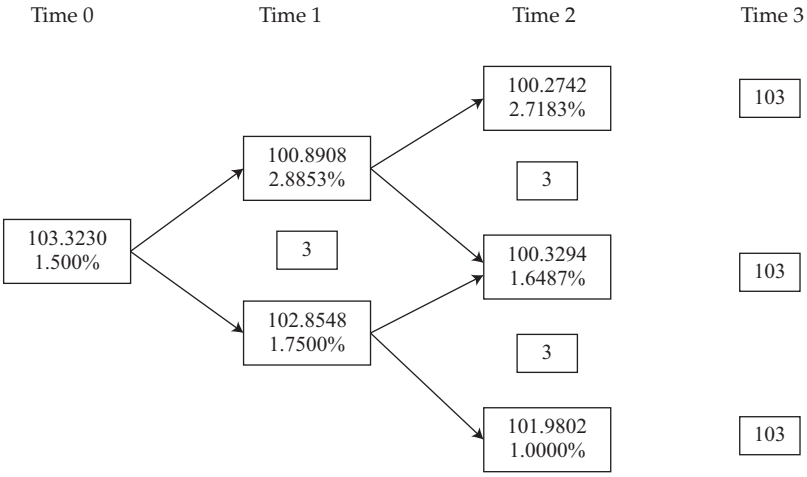
11 B is correct. Based on the dominance principle, an arbitrage opportunity exists. The dominance principle asserts that a financial asset with a risk-free payoff in the future must have a positive price today. Because Asset A and Asset B are both risk-free assets, they should have the same discount rate. Relative to its payoff, Asset A is priced at \$500/525, or 0.95238, and Asset B is priced at \$1,000/1,100, or 0.90909. Given its higher implied discount rate (10%) and lower corresponding price, Asset B is cheap relative to Asset A, which has a lower implied discount rate (5%) and higher corresponding price.

The arbitrage opportunity based on dominance is to sell two units of Asset A for \$1,000 and buy one unit of Asset B. There is no cash outlay today, and in one year, the portfolio delivers a net cash inflow of \$50 [= \$1,100 – (2 × \$525)].

12 B is correct. Of the three markets, the New York bond has the lowest yield to maturity and, correspondingly, the highest bond price. Similarly, the Hong Kong bond has the highest yield to maturity and the lowest bond price of the three markets. Therefore, the most profitable arbitrage trade would be to buy the bond in Hong Kong and sell it in New York.

13 B is correct. The bond value at the upper node at Time 1 is closest to 99.6255. The cash flow at Time 2 is 102.5, the redemption of par value (100) plus the final coupon payment (2.5). Using backward induction, we calculate the present value of the bond at the upper node of Time 1 as 102.5/1.028853 = 99.6255.

14 B is correct. The price of Bond D is closest to 103.3230 and can be calculated using backward induction.



$$\text{Bond value at a node} = \frac{C + \left(0.5 \times VH + 0.5 \times VL\right)}{1 + i}.$$

Calculations:

The cash flow at Time 3 is 103, the redemption of par value (100) plus the final coupon payment (3).

Time 2 node values:

Upper node: 103/1.027183 = 100.2742

Middle node: 103/1.016487 = 101.3294

Lower node: 103/1.010000 = 101.9802

Working back to Time 1 requires the use of the general expression above.

Time 1 node values:

$$\text{Upper node: } \frac{3 + \left(0.5 \times 100.2742 + 0.5 \times 101.3294\right)}{1.028853} = 100.8908$$

$$\text{Lower node: } \frac{3 + \left(0.5 \times 101.3294 + 0.5 \times 101.9802\right)}{1.0175} = 102.8548$$

Time 0 node value:

$$\frac{3 + \left(0.5 \times 100.8908 + 0.5 \times 102.8548\right)}{1.015} = 103.3230$$

Therefore, the price of the bond is 103.3230.

15 B is correct. Two methods are commonly used to estimate potential interest rate volatility in a binomial interest rate tree. The first method bases estimates on historical interest rate volatility. The second method uses observed market prices of interest rate derivatives.

Statement 1 is incorrect because there are three requirements to create a binomial interest rate tree, not two. The third requirement is an assumption regarding the interest rate model. Statement 3 is incorrect because the valuation of a bond using spot rates and the valuation of a bond from an interest rate tree will be the same regardless of the volatility assumption used in the model.

16 B is correct. The value of the lower one-period forward rate is closest to 3.5400%, calculated as $0.058365 \times e^{-0.50} = 0.035400$.

17 B is correct. The present value of Bond D's cash flows following Path 2 is 102.8607 and can be calculated as follows:

$$\frac{3}{1.015} + \frac{3}{(1.015)(1.028853)} + \frac{103}{(1.015)(1.028853)(1.016487)} = 102.8607$$

18 A is correct. Increasing the number of paths using the Monte Carlo method does increase the estimate's statistical accuracy. It does not, however, provide a value that is closer to the bond's true fundamental value.

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PRACTICE PROBLEMS

The following information relates to Questions 1–10

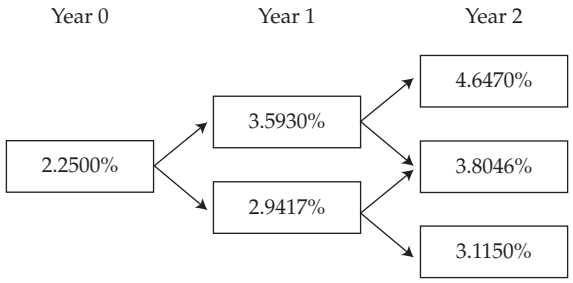
Samuel & Sons is a fixed-income specialty firm that offers advisory services to investment management companies. On 1 October 20X0, Steele Ferguson, a senior analyst at Samuel, is reviewing three fixed-rate bonds issued by a local firm, Pro Star, Inc. The three bonds, whose characteristics are given in Exhibit 1, carry the highest credit rating.

Exhibit 1 Fixed-Rate Bonds Issued by Pro Star, Inc.

Bond	Maturity	Coupon	Type of Bond
Bond #1	1 October 20X3	4.40% annual	Option-free
Bond #2	1 October 20X3	4.40% annual	Callable at par on 1 October 20X1 and on 1 October 20X2
Bond #3	1 October 20X3	4.40% annual	Putable at par on 1 October 20X1 and on 1 October 20X2

The one-year, two-year, and three-year par rates are 2.250%, 2.750%, and 3.100%, respectively. Based on an estimated interest rate volatility of 10%, Ferguson constructs the binomial interest rate tree shown in Exhibit 2.

Exhibit 2 Binomial Interest Rate Tree



On 19 October 20X0, Ferguson analyzes the convertible bond issued by Pro Star given in Exhibit 3. That day, the option-free value of Pro Star's convertible bond is $1,060 and Pro Star's stock price is and $37.50.

Exhibit 3 Convertible Bond Issued by Pro Star, Inc.

Issue Date:	6 December 20X0
Maturity Date:	6 December 20X4
Coupon Rate:	2%
Issue Price:	$1,000
Conversion Ratio:	31

1 The call feature of Bond #2 is *best* described as:

A European style.

B American style.

C Bermudan style.

2 The bond that would *most likely* protect investors against a significant increase in interest rates is:

A Bond #1.

B Bond #2.

C Bond #3.

3 A fall in interest rates would *most likely* result in:

A a decrease in the effective duration of Bond #3.

B Bond #3 having more upside potential than Bond #2.

C a change in the effective convexity of Bond #3 from positive to negative.

4 The value of Bond #2 is *closest* to:

A 102.103% of par.

B 103.121% of par.

C 103.744% of par.

5 The value of Bond #3 is *closest* to:

A 102.103% of par.

B 103.688% of par.

C 103.744% of par.

6 All else being equal, a rise in interest rates will *most likely* result in the value of the option embedded in Bond #3:

A decreasing.

B remaining unchanged.

C increasing.

7 All else being equal, if Ferguson assumes an interest rate volatility of 15% instead of 10%, the bond that would *most likely* increase in value is:

A Bond #1.

B Bond #2.

C Bond #3.

8 All else being equal, if the shape of the yield curve changes from upward sloping to flattening, the value of the option embedded in Bond #2 will *most likely*:

A decrease.

B remain unchanged.

C increase.

9 The conversion price of the bond in Exhibit 3 is closest to:

A $26.67.

B $32.26.

C $34.19.

10 If the market price of Pro Star's common stock falls from its level on 19 October 20X0, the price of the convertible bond will *most likely*:

A fall at the same rate as Pro Star's stock price.

B fall but at a slightly lower rate than Pro Star's stock price.

C be unaffected until Pro Star's stock price reaches the conversion price.

The following information relates to Question 11–19

Rayes Investment Advisers specializes in fixed-income portfolio management. Meg Rayes, the owner of the firm, would like to add bonds with embedded options to the firm's bond portfolio. Rayes has asked Mingfang Hsu, one of the firm's analysts, to assist her in selecting and analyzing bonds for possible inclusion in the firm's bond portfolio.

Hsu first selects two corporate bonds that are callable at par and have the same characteristics in terms of maturity, credit quality and call dates. Hsu uses the option adjusted spread (OAS) approach to analyse the bonds, assuming an interest rate volatility of 10%. The results of his analysis are presented in Exhibit 1.

Exhibit 1 Summary Results of Hsu's Analysis Using the OAS Approach

Bond	OAS (in bps)
Bond #1	25.5
Bond #2	30.3

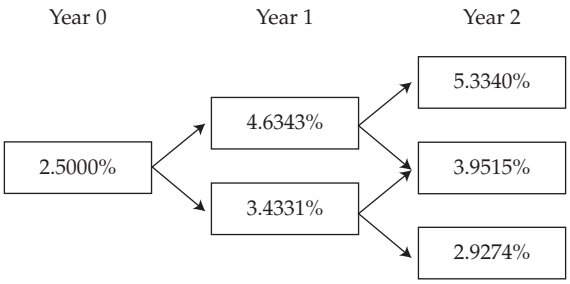
Hsu then selects the four bonds issued by RW, Inc. given in Exhibit 2. These bonds all have a maturity of three years and the same credit rating. Bonds #4 and #5 are identical to Bond #3, an option-free bond, except that they each include an embedded option.

Exhibit 2 Bonds Issued by RW, Inc.

Bond	Coupon	Special Provision
Bond #3	4.00% annual	
Bond #4	4.00% annual	Callable at par at the end of years 1 and 2
Bond #5	4.00% annual	Putable at par at the end of years 1 and 2
Bond #6	One-year Libor annually, set in arrears	

To value and analyze RW's bonds, Hsu uses an estimated interest rate volatility of 15% and constructs the binomial interest rate tree provided in Exhibit 3.

Exhibit 3 Binomial Interest Rate Tree Used to Value RW's Bonds



Rayes asks Hsu to determine the sensitivity of Bond #4's price to a 20 bps parallel shift of the benchmark yield curve. The results of Hsu's calculations are shown in Exhibit 4.

Exhibit 4 Summary Results of Hsu's Analysis about the Sensitivity of Bond #4's Price to a Parallel Shift of the Benchmark Yield Curve

Magnitude of the Parallel Shift in the Benchmark Yield Curve	+20 bps	–20 bps
Full Price of Bond #4 (% of par)	100.478	101.238

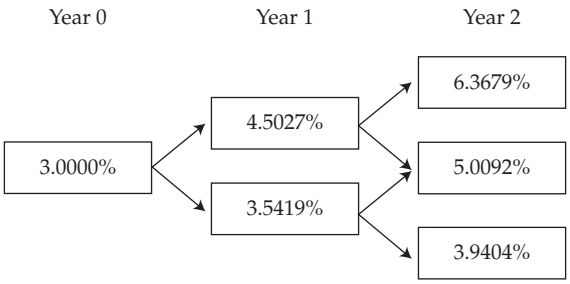
Hsu also selects the two floating-rate bonds issued by Varlep, plc given in Exhibit 5. These bonds have a maturity of three years and the same credit rating.

Exhibit 5 Floating-Rate Bonds Issued by Varlep, plc

Bond	Coupon
Bond #7	One-year Libor annually, set in arrears, capped at 5.00%
Bond #8	One-year Libor annually, set in arrears, floored at 3.50%

To value Varlep's bonds, Hsu constructs the binomial interest rate tree provided in Exhibit 6.

Exhibit 6 Binomial Interest Rate Tree Used to Value Varlep's Bonds



Last, Hsu selects the two bonds issued by Whorton, Inc. given in Exhibit 7. These bonds are close to their maturity date and are identical, except that Bond #9 includes a conversion option. Whorton's common stock is currently trading at $30 per share.

Exhibit 7 Bonds Issued by Whorton, Inc.

Bond	Type of Bond
Bond #9	Convertible bond with a conversion price of $50
Bond #10	Identical to Bond #9 except that it does not include a conversion option

11 Based on Exhibit 1, Rayes would *most likely* conclude that relative to Bond #1, Bond #2 is:

A overpriced.

B fairly priced.

C underpriced.

12 The effective duration of Bond #6 is:

A lower than or equal to 1.

B higher than 1 but lower than 3.

C higher than 3.

13 In Exhibit 2, the bond whose effective duration will lengthen if interest rates rise is:

A Bond #3.

B Bond #4.

C Bond #5.

14 The effective duration of Bond #4 is *closest* to:

A 0.76.

B 1.88.

C 3.77.

15 The value of Bond #7 is *closest* to:

A 99.697% of par.

B 99.936% of par.

C 101.153% of par.

16 The value of Bond #8 is *closest* to:

A 98.116% of par.

B 100.000% of par.

C 100.485% of par.

17 The value of Bond #9 is equal to the value of Bond #10:

A plus the value of a put option on Whorton's common stock.

B plus the value of a call option on Whorton's common stock.

C minus the value of a call option on Whorton's common stock.

18 The minimum value of Bond #9 is equal to the *greater* of:

A the conversion value of Bond #9 and the current value of Bond #10.

B the current value of Bond #10 and a call option on Whorton's common stock.

C the conversion value of Bond #9 and a call option on Whorton's common stock.

19 The factor that is currently *least likely* to affect the risk-return characteristics of Bond #9 is:

A Interest rate movements.

B Whorton's credit spreads.

C Whorton's common stock price movements.

The following information relates to Question 20–27

John Smith, an investment adviser, meets with Lydia Carter to discuss her pending retirement and potential changes to her investment portfolio. Domestic economic activity has been weakening recently, and Smith's outlook is that equity market values will be lower during the next year. He would like Carter to consider reducing her equity exposure in favor of adding more fixed-income securities to the portfolio.

Government yields have remained low for an extended period, and Smith suggests considering investment-grade corporate bonds to provide additional yield above government debt issues. In light of recent poor employment figures and two consecutive quarters of negative GDP growth, the consensus forecast among economists is that the central bank, at its next meeting this month, will take actions that will lead to lower interest rates.

Smith and Carter review par, spot, and one-year forward rates (Exhibit 1) and four fixed-rate investment-grade bonds issued by Alpha Corporation which are being considered for investment (Exhibit 2).

Exhibit 1 Par, Spot, and One-Year Forward Rates (annual coupon payments)

Maturity (Years)	Par Rate (%)	Spot Rate (%)	One-Year Forward (%)
1	1.0000	1.0000	1.0000
2	1.2000	1.2012	1.4028
3	1.2500	1.2515	1.3522

Exhibit 2 Selected Fixed-Rate Bonds of Alpha Corporation

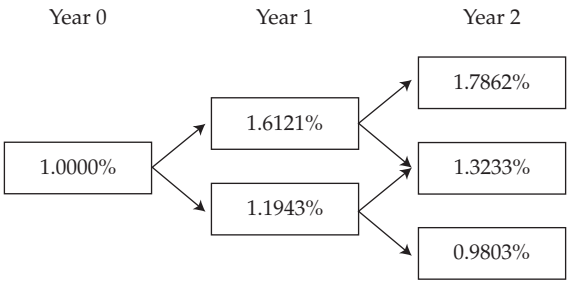
Bond	Annual Coupon	Type of Bond
Bond 1	1.5500%	Straight bond
Bond 2	1.5500%	Convertible bond: currently trading out of the money
Bond 3	1.5500%	Putable bond: putable at par one year and two years from now
Bond 4	1.5500%	Callable bond: callable at par without any lockout periods

Note: All bonds in Exhibit 2 have remaining maturities of exactly three years.

Carter tells Smith that the local news media have been reporting that housing starts, exports, and demand for consumer credit are all relatively strong, even in light of other poor macroeconomic indicators. Smith explains that the divergence in economic data leads him to believe that volatility in interest rates will increase. Smith also states that he recently read a report issued by Brown and Company forecasting that the yield curve could invert within the next six months.

Smith develops a binomial interest rate tree with a 15% interest rate volatility assumption to assess the value of Alpha Corporation's bonds. Exhibit 3 presents the interest rate tree.

Exhibit 3 Binomial Interest Rate Tree for Alpha Corporation 15% Interest Rate Volatility



Carter asks Smith about the possibility of analyzing bonds that have lower credit ratings than the investment-grade Alpha bonds. Smith discusses four other corporate bonds with Carter. Exhibit 4 presents selected data on the four bonds.

Exhibit 4 Selected Information on Fixed-Rate Bonds for Beta, Gamma, Delta, and Rho Corporations

Bond	Issuer	Bond Features	Credit Rating
Bond 5	Beta Corporation	Coupon 1.70% Callable in Year 2 OAS of 45 bps	B
Bond 6	Gamma Corporation	Coupon 1.70% Callable in Year 2 OAS of 65 bps	B

Exhibit 4 (Continued)

Bond	Issuer	Bond Features	Credit Rating
Bond 7	Delta Corporation	Coupon 1.70% Callable in Year 2 OAS of 85 bps	B
Bond 8	Rho Corporation	Coupon 1.70% Callable in Year 2 OAS of 105 bps	CCC

Notes: All bonds have remaining maturities of three years. OAS stands for option-adjusted spread.

20 Based on Exhibit 2, and assuming that the forecast for interest rates and Smith's outlook for equity returns are validated, which bond's option is *most likely* to be exercised?

A Bond 2

B Bond 3

C Bond 4

21 Based on Exhibit 2, the current price of Bond 1 is *most likely* greater than the current price of:

A Bond 2.

B Bond 3.

C Bond 4.

22 Assuming the forecast for interest rates is proven accurate, which bond in Exhibit 2 will likely experience the smallest price increase?

A Bond 1

B Bond 3

C Bond 4

23 Based on the information in Exhibit 1 and Exhibit 2, the value of the embedded option in Bond 4 is *closest* to:

A nil.

B 0.1906.

C 0.3343.

24 If Smith's interest rate volatility forecast turns out to be true, which bond in Exhibit 2 is likely to experience the greatest price increase?

A Bond 2

B Bond 3

C Bond 4

25 If the Brown and Company forecast comes true, which of the following is *most* likely to occur? The value of the embedded option in:

A Bond 3 decreases.

B Bond 4 decreases.

C both Bond 3 and Bond 4 increases.

26 Based on Exhibit 2 and Exhibit 3, the market price of Bond 4 is *closest* to:

A 100.4578.

B 100.5123.

C 100.8790.

27 Which of the following conclusions regarding the bonds in Exhibit 4 is correct?

A Bond 5 is relatively cheaper than Bond 6.

B Bond 7 is relatively cheaper than Bond 6.

C Bond 8 is relatively cheaper than Bond 7.

The following information relates to Questions 28-36

Jules Bianchi is a bond analyst for Maneval Investments, Inc. Bianchi gathers data on three corporate bonds, as shown in Exhibit 1.

Exhibit 1 Selected Bond Data

Issuer	Coupon Rate	Price	Bond Description
Ayrault, Inc. (AI)	5.25%	100.200	Callable at par in one year and two years from today
Blum, Inc. (BI)	5.25%	101.300	Option-free
Cresson Enterprises (CE)	5.25%	102.100	Putable at par in one year from today

Note: Each bond has a remaining maturity of three years, annual coupon payments, and a credit rating of BBB.

To assess the interest rate risk of the three bonds, Bianchi constructs two binomial interest rate trees based on a 10% interest rate volatility assumption and a current one-year rate of 1%. Panel A of Exhibit 2 provides an interest rate tree assuming the benchmark yield curve shifts down by 30 bps, and Panel B provides an interest rate tree assuming the benchmark yield curve shifts up by 30 bps. Bianchi determines that the AI bond is currently trading at an option-adjusted spread (OAS) of 13.95 bps relative to the benchmark yield curve.

Exhibit 2 Binomial Interest Rate Trees

Panel A Interest Rates Shift Down by 30 bps

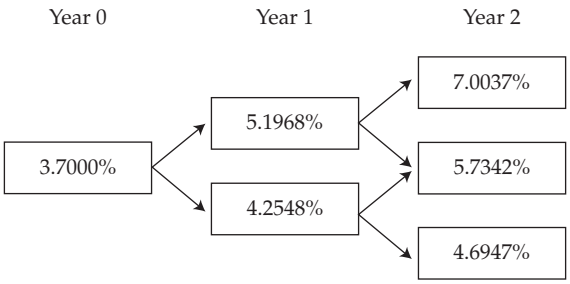
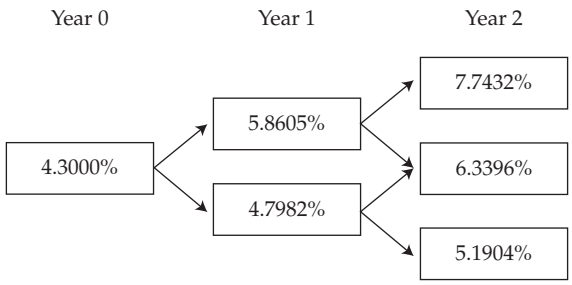


Exhibit 2 (Continued)

Panel B Interest Rates Shift Up by 30 bps



Armand Gillette, a convertible bond analyst, stops by Bianchi's office to discuss two convertible bonds. One is issued by DeLille Enterprises (DE) and the other is issued by Raffarin Incorporated (RI). Selected data for the two bonds are presented in Exhibits 3 and 4.

Exhibit 3 Selected Data for DE Convertible Bond

Issue price	€1,000 at par
Conversion period	13 September 20X5 to 12 September 20X8
Initial conversion price	€10.00 per share
Threshold dividend	€0.50 per share
Change of control conversion price	€8.00 per share
Common stock share price on issue date	€8.70
Share price on 17 September 20X5	€9.10
Convertible bond price on 17 September 20X5	€1,123

Exhibit 4 Selected Data for RI Convertible Bond

Straight bond value	€978
Value of embedded issuer call option	€43
Value of embedded investor put option	€26
Value of embedded call option on issuer's stock	€147
Conversion price	€12.50
Current common stock share price	€11.75

Gillette makes the following comments to Bianchi:

- "The DE bond does not contain any call or put options but the RI bond contains both an embedded call option and put option. I expect that DeLille Enterprises will soon announce a common stock dividend of €0.70 per share."
- "My belief is that, over the next year, Raffarin's share price will appreciate toward the conversion price but not exceed it."

28 Based on Exhibits 1 and 2, the effective duration for the AI bond is *closest to*:

A 1.98.

B 2.15.

C 2.73.

29 If benchmark yields were to fall, which bond in Exhibit 1 would *most likely* experience a decline in effective duration?

A AI bond

B BI bond

C CE bond

30 Based on Exhibit 1, for the BI bond, one-sided:

A up-duration will be greater than one-sided down-duration.

B down-duration will be greater than one-sided up-duration.

C up-duration and one-sided down-duration will be about equal.

31 Based on Exhibit 1, which key rate duration is the largest for the BI bond?

A One-year key rate duration

B Two-year key rate duration

C Three-year key rate duration

32 Which bond in Exhibit 1 *most likely* has the lowest effective convexity?

A AI bond

B BI bond

C CE bond

33 Based on Exhibit 3, if DeLille Enterprises pays the dividend expected by Gillette, the conversion price of the DE bond will:

A be adjusted downward.

B not be adjusted.

C be adjusted upward.

34 Based on Exhibit 3, the market conversion premium per share for the DE bond on 17 September 20X5 is *closest* to:

A €0.90.

B €2.13.

C €2.53.

35 Based on Exhibit 4, the arbitrage-free value of the RI bond is *closest* to:

A €814.

B €1,056.

C €1,108.

36 Based on Exhibit 4 and Gillette's forecast regarding Raffarin's share price, the return on the RI bond over the next year is *most likely* to be:

A lower than the return on Raffarin's common shares.

B the same as the return on Raffarin's common shares.

C higher than the return on Raffarin's common shares.

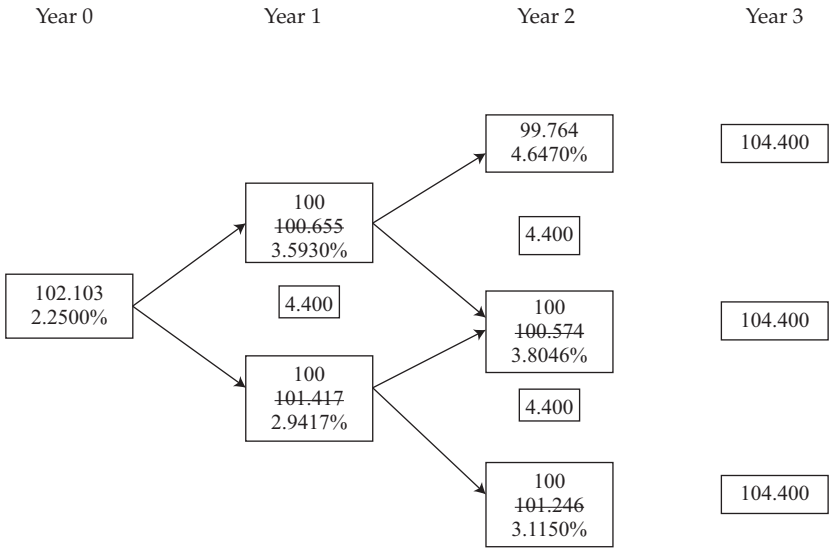
SOLUTIONS

1 C is correct. The call option embedded in Bond #2 can be exercised only at two predetermined dates: 1 October 20X1 and 1 October 20X2. Thus, the call feature is Bermudan style.

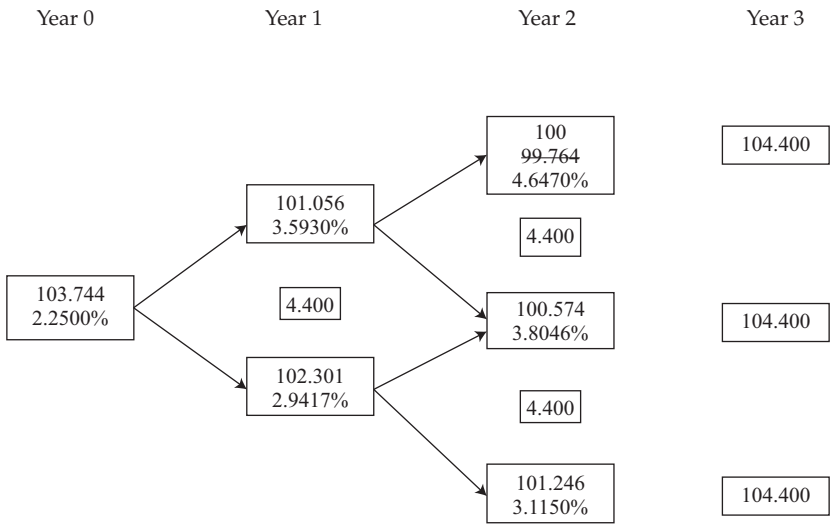
2 C is correct. The bond that would most likely protect investors against a significant increase in interest rates is the putable bond, i.e., Bond #3. When interest rates have risen and higher-yield bonds are available, a put option allows the bondholders to put back the bonds to the issuer prior to maturity and to reinvest the proceeds of the retired bonds in higher-yielding bonds.

3 B is correct. A fall in interest rates results in a rise in bond values. For a callable bond such as Bond #2, the upside potential is capped because the issuer is more likely to call the bond. In contrast, the upside potential for a putable bond such as Bond #3 is uncapped. Thus, a fall in interest rates would result in a putable bond having more upside potential than an otherwise identical callable bond. Note that A is incorrect because the effective duration of a putable bond increases, not decreases, with a fall in interest rates—the bond is less likely to be put and thus behaves more like an option-free bond. C is also incorrect because the effective convexity of a putable bond is always positive. It is the effective convexity of a callable bond that will change from positive to negative if interest rates fall and the call option is near the money.

4 A is correct:



5 C is correct:



6 C is correct. Bond #3 is a putable bond, and the value of a put option increases as interest rates rise. At higher interest rates, the value of the underlying option-free bond (straight bond) declines, but the decline is offset partially by the increase in the value of the embedded put option, which is more likely to be exercised.

7 C is correct. Regardless of the type of option, an increase in interest rate volatility results in an increase in option value. Because the value of a putable bond is equal to the value of the straight bond *plus* the value of the embedded put option, Bond #3 will increase in value if interest rate volatility increases. Put another way, an increase in interest rate volatility will most likely result in more scenarios where the put option is exercised, which increases the values calculated in the interest rate tree and, thus, the value of the putable bond.

8 C is correct. Bond #2 is a callable bond, and the value of the embedded call option increases as the yield curve flattens. When the yield curve is upward sloping, the one-period forward rates on the interest rate tree are high and opportunities for the issuer to call the bond are fewer. When the yield curve flattens or inverts, many nodes on the tree have lower forward rates, which increases the opportunities to call and, thus, the value of the embedded call option.

9 B is correct. The conversion price of a convertible bond is equal to the par value divided by the conversion ratio—that is, \$1,000/31= \$32.26 per share.

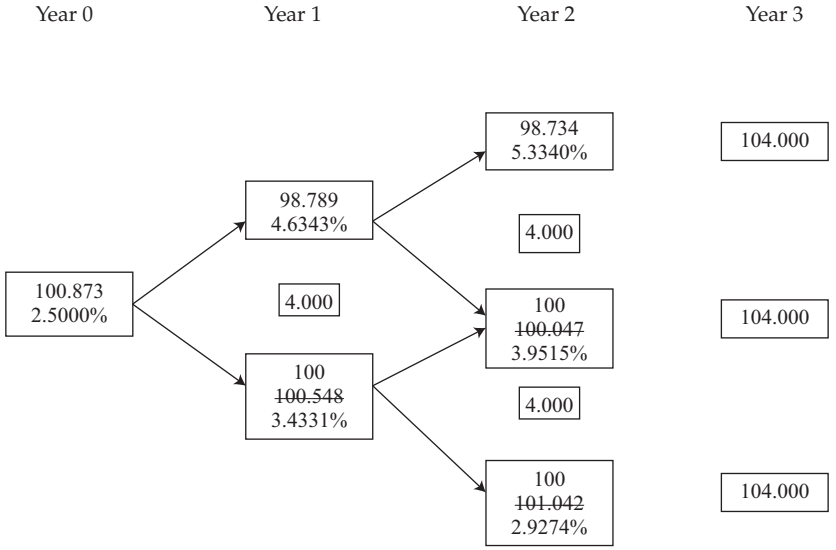
10 B is correct. The conversion value of the bond is 31 × \$37.50 or \$1,162.50, which represents its minimum value. Thus, the convertible bond exhibits mostly stock risk-return characteristics, and a fall in the stock price will result in a fall in the convertible bond price. However, the change in the convertible bond price is less than the change in the stock price because the convertible bond has a floor—that floor is the value of the straight (option-free) bond.

11 C is correct. The option-adjusted spread (OAS) is the constant spread added to all the one-period forward rates that makes the arbitrage-free value of a risky bond equal to its market price. The OAS approach is often used to assess bond relative values. If two bonds have the same characteristics and credit quality, they should have the same OAS. If this is not the case, the bond with the largest OAS (i.e., Bond #2) is likely to be underpriced (cheap) relative to the bond with the smallest OAS (Bond #1).

12 A is correct. The effective duration of a floating-rate bond is close to the time to next reset. As the reset for Bond #6 is annual, the effective duration of this bond is lower than or equal to 1.

13 B is correct. Effective duration indicates the sensitivity of a bond's price to a 100 bps parallel shift of the benchmark yield curve assuming no change in the bond's credit spread. The effective duration of an option-free bond such as Bond #3 changes very little in response to interest rate movements. As interest rates rise, a call option moves out of the money, which increases the value of the callable bond and lengthens its effective duration. In contrast, as interest rates rise, a put option moves into the money, which limits the price depreciation of the putable bond and shortens its effective duration. Thus, the bond whose effective duration will lengthen if interest rates rise is the callable bond, i.e., Bond #4.

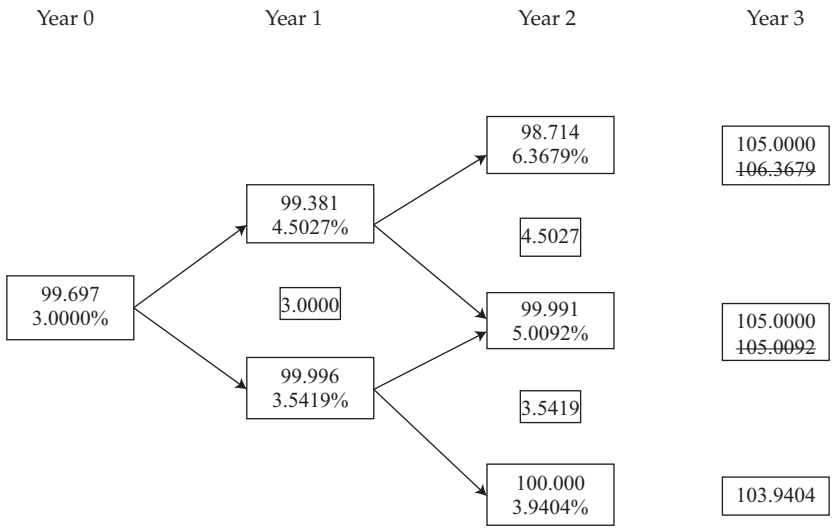
14 B is correct. The effective duration of Bond #4 can be calculated using Equation 3 from the reading, where ΔCurve is 20 bps, PV_- is 101.238, and PV_+ is 100.478. PV_0, the current full price of the bond (i.e., with no shift), is not given but it can be calculated using Exhibit 3 as follows:



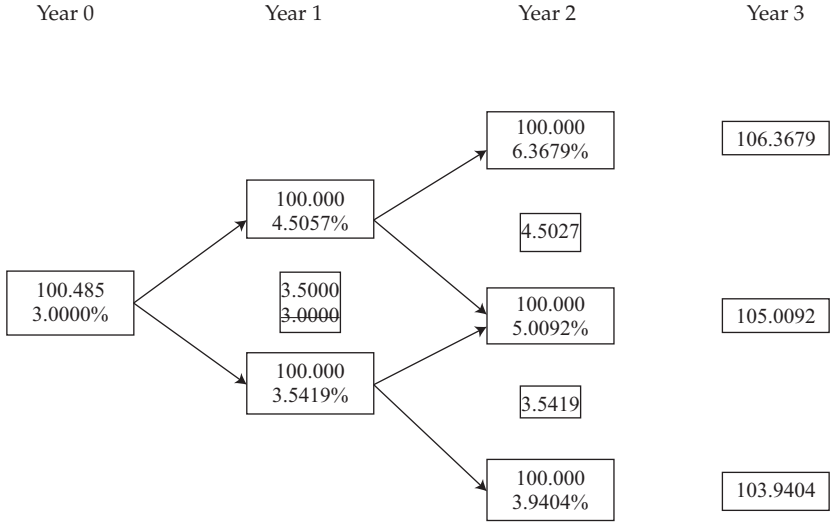
Thus, the effective duration of Bond #4 is:

$$\text{Effective duration} = \frac{101.238 - 100.478}{2 \times (0.0020) \times (100.873)} = 1.88$$

15 A is correct:



16 C is correct:



17 B is correct. A convertible bond includes a conversion option, which is a call option on the issuer's common stock. This conversion option gives the bondholders the right to convert their debt into equity. Thus, the value of Bond #9, the convertible bond, is equal to the value of Bond #10, the underlying option-free bond (straight bond), plus the value of a call option on Whorton's common stock.

18 A is correct. The minimum value of a convertible bond is equal to the greater of the conversion value of the convertible bond (i.e., Bond #9) and the current value of the straight bond (i.e., Bond #10).

19 C is correct. The risk-return characteristics of a convertible bond depend on the market price of the issuer's common stock (underlying share price) relative to the bond's conversion price. When the underlying share price is well below the conversion price, the convertible bond exhibits mostly bond risk-return characteristics. In this case, the price of the convertible bond is mainly affected by interest rate movements and the issuer's credit spreads. In contrast, when the underlying share price is above the conversion price, the convertible bond exhibits mostly stock risk-return characteristics. In this case, the price of the convertible bond is mainly affected by the issuer's common stock price

movements. The underlying share price ($30) is lower than the conversion price of Bond #9 ($50). Thus, Bond #9 exhibits mostly bond risk-return characteristics and is least affected by Whorton's common stock price movements.

20 C is correct. If the central bank takes actions that lead to lower interest rates, the yields on Alpha's bonds are likely to decrease. If the yield to maturity on Bond 4 (callable) falls below the 1.55% coupon rate, the call option will become valuable and Alpha may call the bond because it is in the money.

A is incorrect because if the equity market declines, the market value of Alpha stock will also likely decrease. Therefore, Bond 2 (convertible) would have a lower conversion value, and hence, the conversion option likely would not be exercised. Because Bond 2 is currently trading out of the money, it will likely trade further out of the money once the price of Alpha stock decreases.

B is incorrect because Bond 3 (putable) is more likely to be exercised in an increasing rather than a decreasing interest rate environment.

21 C is correct. All four bonds in Exhibit 2 issued by Alpha Corporation offer the same coupon rate and have the same remaining term to maturity. Bond 4 (callable) most likely has a current price that is less than Bond 1 (straight or option free) because investors are short the call option and must be compensated for bearing call risk. Bond 2 (convertible) most likely has a current price that is greater than Bond 1 because investors are paying for the conversion option embedded in Bond 2 and the option has time value associated with it, even though the option is trading out of the money. Similarly, Bond 3 (putable) most likely has a current price that is greater than Bond 1 because investors are paying for the put option.

22 C is correct. The consensus economic forecast is for interest rates to decrease. In an environment of decreasing interest rates, all bond prices should rise ignoring any price impact resulting from any embedded options. When interest rates fall, the value of the embedded call option in Bond 4 (callable) increases, causing an opposing effect on price. The put option of putable bonds, by contrast, increases in value when interest rates rise rather than decline.

23 C is correct. Bond 4 is a callable bond. Value of an issuer call option = Value of straight bond − Value of callable bond. The value of the straight bond may be calculated using the spot rates or the one-year forward rates.

Value of an option-free (straight) bond with a 1.55% coupon using spot rates:

$$1.55/(1.0100)^1 + 1.55/(1.012012)^2 + 101.55/(1.012515)^3 = 100.8789.$$

The value of a callable bond (at par) with no lockout period and a 1.55% coupon rate is 100.5446, as shown in the following table:

	Today	Year 1	Year 2	Year 3
Cash flow		1.55	1.55	100 + 1.55
One-year forward		1.0000%	1.4028%	1.3522%
Value of bond	101.55/1.010000 = 100.5446	101.55/1.014028 = 100.1452 Called at 100	101.55/1.013522 = 100.1952 Called at 100	

The value of the call option = 100.8789 − 100.5446 = 0.3343.

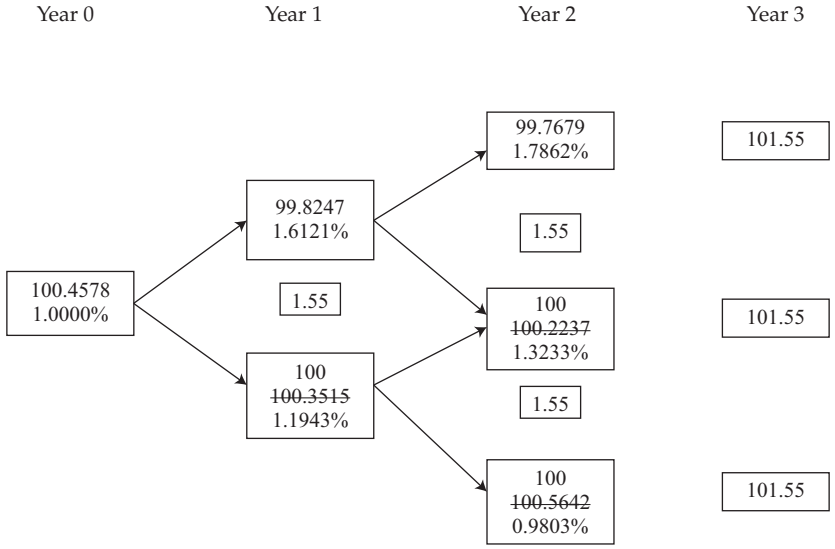
24 B is correct. An increase in interest rate volatility will cause the value of the put and call options embedded in Bond 3 and Bond 4 to increase. Bond 3 (putable) would experience an increase in price because the increased value of the put option increases the bond's value. In contrast, Bond 4 (callable) will experience a price decrease because the increased value of the call option reduces the

callable bond's value. Bond 2, an out-of-the-money convertible, will resemble the risk–return characteristics of a straight bond and will thus be unaffected by interest rate volatility.

25 A is correct. All else being equal, the value of a put option decreases as the yield curve moves from being upward sloping to flat to downward sloping (inverted). Alternatively, a call option's value increases as the yield curve flattens and increases further if the yield curve inverts. Therefore, if the yield curve became inverted, the value of the embedded option in Bond 3 (putable) would decrease and the value of the embedded option in Bond 4 (Callable) would increase.

26 A is correct. The market price of Bond 4 using the binomial interest rate tree is 100.4578.

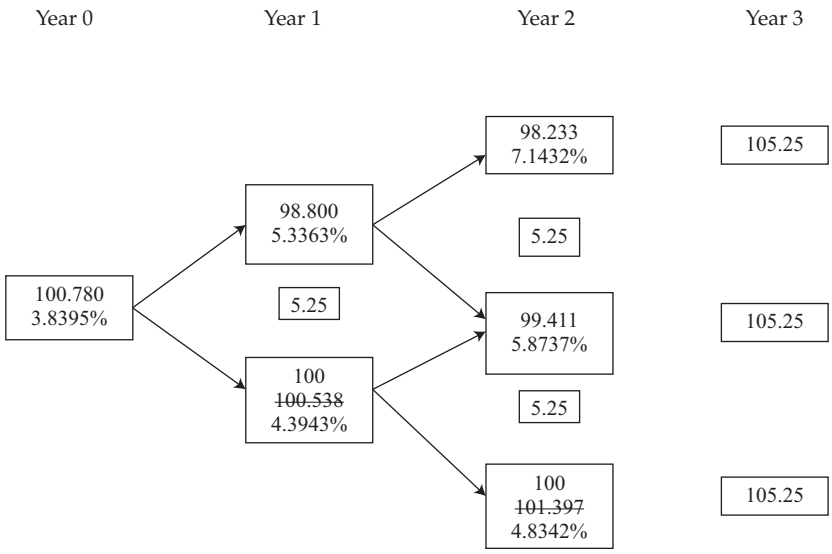
The valuation of Bond 4 (Callable) with a 1.55% coupon, no lockout periods, and 15% volatility is shown in the following table.



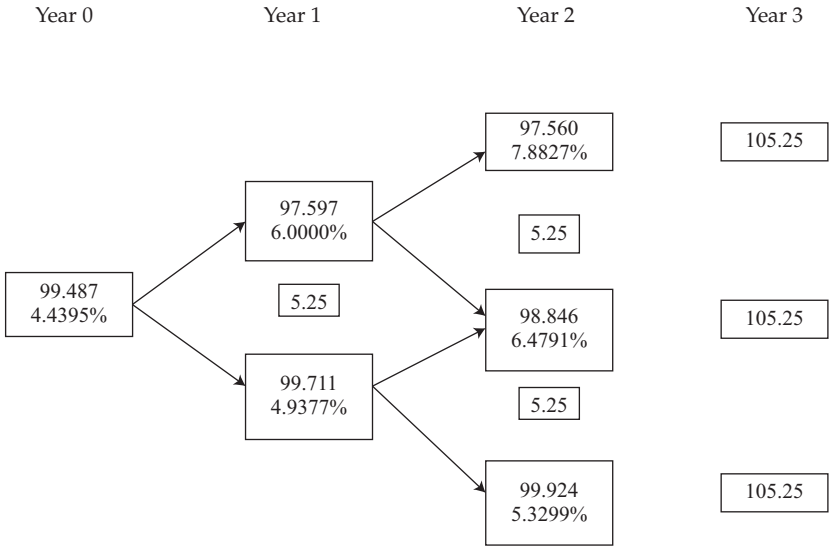
27 B is correct. A bond with a larger option-adjusted spread (OAS) than that of a bond with similar characteristics and credit quality means that the bond is likely underpriced (cheap). Bond 7 (OAS 85 bps) is relatively cheaper than Bond 6 (OAS 65 bps).

C is incorrect because Bond 8 (CCC) has a lower credit rating than Bond 7 (B) and the OAS alone cannot be used for the relative value comparison. The larger OAS (105 bps) incorporates compensation for the difference between the B and CCC bond credit ratings. Therefore, there is not enough information to draw a conclusion about relative value.

28 B is correct. The AI bond's value if interest rates shift down by 30 bps (PV_) is 100.78:



The AI bond's value if interest rates shift up by 30 bps (PV_+) is 99.487:



$$\text{Effective duration} = \frac{(PV_-) - (PV_+)}{2 \times (\Delta\text{Curve}) \times (PV_0)} = \frac{100.780 - 99.487}{2 \times 0.003 \times 100.200} = 2.15$$

29 A is correct. The AI bond is a callable bond and the effective duration of a callable bond decreases when interest rates fall. The reason is because a decline in interest rates may result in the call option moving into the money, which limits the price appreciation of the callable bond. Exhibit 1 also shows that the price of the AI bond is 100.200 and that it is callable at par in one year and two years. Thus, the call option is already in the money and would likely be exercised in response to increases in the AI bond's price.

30 C is correct. The BI bond is an option-free bond and one-sided up-duration and one-sided down-duration will be about equal for option-free bonds.

31 C is correct. The BI bond is an option-free bond. Its longest key rate duration will be in the year of its maturity because the largest cash flow (payment of both coupon and principal) occurs in that year.

32 A is correct. All else being equal, a callable bond will have lower effective convexity than an option-free bond when the call option is in the money. Similarly, when the call option is in the money, a callable bond will also have lower

effective convexity than a putable bond if the put option is out of the money. Exhibit 1 shows that the callable AI bond is currently priced slightly higher than its call price of par value, which means the embedded call option is in the money. The put option embedded in the CE bond is not in the money; the bond is currently priced 2.1% above par value. Thus, at the current price, the putable CE bond is more likely to behave like the option-free BI bond. Consequently, the effective convexity of the AI bond will likely be lower than the option-free BI bond and the putable CE bond.

33 A is correct. The conversion price would be adjusted downward because Gillette's expected dividend payment of €0.70 is greater than the threshold dividend of €0.50.

34 B is correct. The market conversion premium per share is equal to the market conversion price minus the underlying share price. The market conversion price is calculated as follows:

$$\text{Market conversion price} = \frac{\text{Convertible bond price}}{\text{Conversion ratio}}$$

$$= \frac{€1{,}123}{€1{,}000/€10 \text{ per share}} = €11.23 \text{ per share}$$

The market conversion premium per share is then calculated as follows:

$$\text{Market conversion premium per share} = \text{Market conversion price} - \text{Underlying share price}$$
$$= €11.23 - €9.10 = €2.13$$

35 C is correct. The value of a convertible bond with both an embedded call option and a put option can be determined using the following formula:

$$\text{Value of callable putable convertible bond} = \text{Value of straight bond} + \text{Value of call option on the issuer's stock} - \text{Value of issuer call option} + \text{Value of investor put option.}$$
$$\text{Value of callable putable bond} = €978 + €147 - €43 + €26 = €1{,}108$$

36 A is correct. Over the next year, Gillette believes that Raffarin's share price will continue to increase towards the conversion price but not exceed it. If Gillette's forecast becomes true, the return on the RI bond will increase but at a lower rate than the increase in Raffarin's share price because the conversion price is not expected to be reached.

PRACTICE PROBLEMS

The following information relates to questions 1–15

Daniela Ibarra is a senior analyst in the fixed-income department of a large wealth management firm. Marten Koning is a junior analyst in the same department, and David Lok is a member of the credit research team.

The firm invests in a variety of bonds. Ibarra is presently analyzing a set of bonds with some similar characteristics, such as four years until maturity and a par value of €1,000. Exhibit 1 includes details of these bonds.

Exhibit 1 A Brief Description of the Bonds Being Analyzed

Bond	Description
B1	A zero-coupon, four-year corporate bond with a par value of €1,000. The wealth management firm's research team has estimated that the risk-neutral probability of default (the hazard rate) for each date for the bond is 1.50%, and the recovery rate is 30%.
B2	A bond similar to B1, except that it has a fixed annual coupon rate of 6% paid annually.
B3	A bond similar to B2 but rated AA.
B4	A bond similar to B2 but the coupon rate is the one-year benchmark rate plus 4%.

Ibarra asks Koning to assist her with analyzing the bonds. She wants him to perform the analysis with the assumptions that there is no interest rate volatility and that the government bond yield curve is flat at 3%.

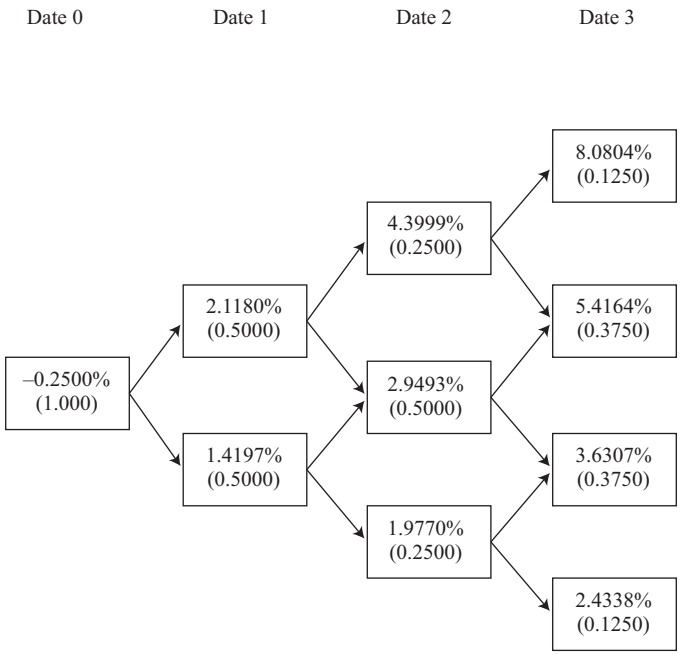
Ibarra performs the analysis assuming an upward-sloping yield curve and volatile interest rates. Exhibit 2 provides the data on annual payment benchmark government bonds.[1] She uses this data to construct a binomial interest rate tree (shown in Exhibit 3) based on an assumption of future interest rate volatility of 20%.

Exhibit 2 Par Curve for Annual Payment Benchmark Government Bonds

Maturity	Coupon Rate	Price	Discount Factor	Spot Rate	Forward Rate
1	–0.25%	€100	1.002506	–0.2500%	
2	0.75%	€100	0.985093	0.7538%	1.7677%
3	1.50%	€100	0.955848	1.5166%	3.0596%
4	2.25%	€100	0.913225	2.2953%	4.6674%

1 For simplicity, this exhibit uses data for the first four years from Exhibit 9 of the reading.

Exhibit 3 One-Year Binomial Interest Rate Tree for 20% Volatility



Answer the first five questions (1–4) based on the assumptions made by Marten Koning, the junior analyst. Answer questions (8–12) based on the assumptions made by Daniela Ibarra, the senior analyst.

Note: All calculations in this problem set are carried out on spreadsheets to preserve precision. The rounded results are reported in the solutions.

1 The market price of bond B1 is €875. The bond is:

A fairly valued.

B overvalued.

C undervalued.

2 Koning realizes that an increase in the recovery rate would lead to an increase in the bond's fair value, whereas an increase in the probability of default would lead to a decrease in the bond's fair value. He is not sure which effect would be greater, however. So, he increases both the recovery rate and the probability of default by 25% of their existing estimates and recomputes the bond's fair value. The recomputed fair value is closest to:

A €843.14.

B €848.00.

C €855.91.

3 The fair value of bond B2 is closest to:

A €1,069.34.

B €1,111.51.

C €1,153.68.

4 The market price of bond B2 is €1,090. If the bond is purchased at this price and there is a default on Date 3, the rate of return to the bond buyer would be closest to:

A –28.38%.

B –41.72%.

C –69.49%.

5 Bond B3 will have a modified duration of 2.75 at the end of the year. Based on the representative one-year corporate transition matrix in Exhibit 7 of the reading and assuming no default, how should the analyst adjust the bond's yield to maturity (YTM) to assess the expected return on the bond over the next year?

A Add 7.7 bps to YTM.

B Subtract 7.7 bps from YTM.

C Subtract 9.0 bps from YTM.

6 David Lok has estimated the probability of default of bond B1 to be 1.50%. He is presenting the approach the research team used to estimate the probability of default. Which of the following statements is Lok likely to make in his presentation if the team used a reduced-form credit model?

A Option pricing methodologies were used, with the volatility of the underlying asset estimated based on historical data on the firm's stock price.

B Regression analysis was used, with the independent variables including both firm-specific variables, such as the debt ratio and return on assets, and macroeconomic variables, such as the rate of inflation and the unemployment rate.

C The default barrier was first estimated followed by the estimation of the probability of default as the portion of the probability distribution that lies below the default barrier.

7 In the presentation, Lok is asked why the research team chose to use a reduced-form credit model instead of a structural model. Which statement is he likely to make in reply?

A Structural models are outdated having been developed in the 1970s; reduced-form models are more modern, having been developed in the 1990s.

B Structural models are overly complex because they require use of option pricing models, whereas reduced-form models use regression analysis.

C Structural models require "inside" information known to company management, whereas reduced-form models can use publicly available data on the firm.

8 As previously mentioned, Ibarra is considering a future interest rate volatility of 20% and an upward-sloping yield curve, as shown in Exhibit 2. Based on her analysis, the fair value of bond B2 is closest to:

A €1,101.24.

B €1,141.76.

C €1,144.63.

9 Ibarra wants to know the credit spread of bond B2 over a theoretical comparable-maturity government bond with the same coupon rate as this bond. The foregoing credit spread is closest to:

A 108 bps.

B 101 bps.

C 225 bps.

10 Ibarra is interested in analyzing how a simultaneous decrease in the recovery rate and the probability of default would affect the fair value of bond B2. She decreases both the recovery rate and the probability of default by 25% of their existing estimates and recomputes the bond's fair value. The recomputed fair value is closest to:

A €1,096.59.

B €1,108.40.

C €1,111.91.

11 The wealth management firm has an existing position in bond B4. The market price of B4, a floating-rate note, is €1,070. Senior management has asked Ibarra to make a recommendation regarding the existing position. Based on the assumptions used to calculate the estimated fair value only, her recommendation should be to:

A add to the existing position.

B hold the existing position.

C reduce the existing position.

12 The issuer of the floating-rate note B4 is in the energy industry. Ibarra personally believes that oil prices are likely to increase significantly within the next year, which will lead to an improvement in the firm's financial health and a decline in the probability of default from 1.50% in Year 1 to 0.50% in Years 2, 3, and 4. Based on these expectations, which of the following statements is correct?

A The CVA will decrease to €22.99.

B The note's fair value will increase to €1,177.26.

C The value of the FRN, assuming no default, will increase to €1,173.55.

13 Floating-rate note B4 is currently rated BBB by Standard & Poor's and Fitch Ratings (and Baa by Moody's Investors Service). Based on the research department assumption about the probability of default in Question 10 and her own assumption in Question 11, which action does Ibarra *most likely* expect from the credit rating agencies?

A Downgrade from BBB to BB

B Upgrade from BBB to AAA

C Place the issuer on watch with a positive outlook

14 During the presentation about how the research team estimates the probability of default for a particular bond issuer, Lok is asked for his thoughts on the shape of the term structure of credit spreads. Which statement is he most likely to include in his response?

A The term structure of credit spreads typically is flat or slightly upward sloping for high-quality investment-grade bonds. High-yield bonds are more sensitive to the credit cycle, however, and can have a more upwardly sloped term structure of credit spreads than investment-grade bonds or even an inverted curve.

B The term structure of credit spreads for corporate bonds is always upward sloping, the more so the weaker the credit quality because probabilities of default are positively correlated with the time to maturity.

C There is no consistent pattern to the term structure of credit spreads. The shape of the credit term structure depends entirely on industry factors.

15 The final question to Lok is about covered bonds. The person asking says, "I've heard about them but don't know what they are." Which statement is Lok most likely to make to describe a covered bond?

A A covered bond is issued in a non-domestic currency. The currency risk is then fully hedged using a currency swap or a package of foreign exchange forward contracts.

B A covered bond is issued with an attached credit default swap. It essentially is a "risk-free" government bond.

C A covered bond is a senior debt obligation giving recourse to the issuer as well as a predetermined underlying collateral pool, often commercial or residential mortgages.

The following information relates to Questions 16–22

Anna Lebedeva is a fixed-income portfolio manager. Paulina Kowalski, a junior analyst, and Lebedeva meet to review several positions in Lebedeva's portfolio.

Lebedeva begins the meeting by discussing credit rating migration. Kowalski asks Lebedeva about the typical impact of credit rating migration on the expected return on a bond. Lebedeva asks Kowalski to estimate the expected return over the next year on a bond issued by Entre Corp. The BBB rated bond has a yield to maturity of 5.50% and a modified duration of 7.54. Kowalski calculates the expected return on the bond over the next year given the partial credit transition and credit spread data in Exhibit 1. She assumes that market spreads and yields will remain stable over the year.

Exhibit 1 One-Year Transition Matrix for BBB Rated Bonds and Credit Spreads

	AAA	AA	A	BBB	BB	B	CCC, CC, C
Probability (%)	0.02	0.30	4.80	85.73	6.95	1.75	0.45
Credit spread	0.60%	0.90%	1.10%	1.50%	3.40%	6.50%	9.50%

Lebedeva next asks Kowalski to analyze a three-year bond, issued by VraiRive S.A., using an arbitrage-free framework. The bond's coupon rate is 5%, with interest paid annually and a par value of 100. In her analysis, she makes the following three assumptions:

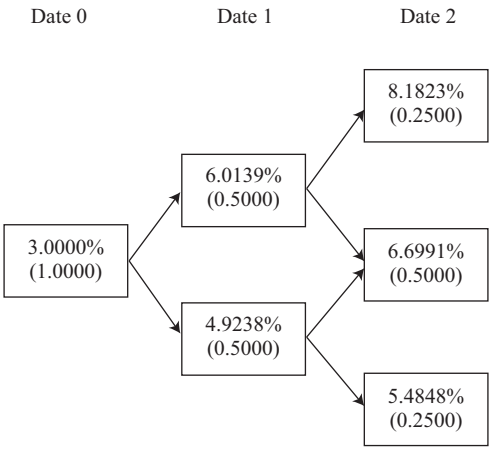
- The annual interest rate volatility is 10%.
- The recovery rate is one-third of the exposure each period.
- The hazard rate, or conditional probability of default each year, is 2.00%.

Selected information on benchmark government bonds for the VraiRive bond is presented in Exhibit 2, and the relevant binomial interest rate tree is presented in Exhibit 3.

Exhibit 2 Par Curve Rates for Annual Payment Benchmark Government Bonds

Maturity	Coupon Rate	Price	Discount Factor	Spot Rate	Forward Rate
1	3.00%	100	0.970874	3.0000%	3.0000%
2	4.20%	100	0.920560	4.2255%	5.4656%
3	5.00%	100	0.862314	5.0618%	6.7547%

Exhibit 3 One-Year Binomial Interest Rate Tree for 10% Volatility (risk-neutral probabilities in parentheses)



Kowalski estimates the value of the VraiRive bond assuming no default (VND) as well as the fair value of the bond. She then estimates the bond's yield to maturity and the bond's credit spread over the benchmark in Exhibit 2. Kowalski asks Lebedeva, "What might cause the bond's credit spread to decrease?"

Lebedeva and Kowalski next discuss the drivers of the term structure of credit spreads. Kowalski tells Lebedeva:

Statement 1 The credit term structure for the most highly rated securities tends to be either flat or slightly upward sloping.

Statement 2 The credit term structure for lower-rated securities is often steeper, and credit spreads widen with expectations of strong economic growth.

Next, Kowalski analyzes the outstanding bonds of DLL Corporation, a high-quality issuer with a strong, competitive position. Her focus is to determine the rationale for a positively sloped credit spread term structure.

Lebedeva ends the meeting by asking Kowalski to recommend a credit analysis approach for a securitized asset-backed security (ABS) held in the portfolio. This non-static asset pool is made up of many medium-term auto loans that are homogeneous, and each loan is small relative to the total value of the pool.

16 The *most appropriate* response to Kowalski's question regarding credit rating migration is that it has:

A a negative impact.

B no impact.

C a positive impact.

17 Based on Exhibit 1, the one-year expected return on the Entre Corp. bond is *closest* to:

A 3.73%.

B 5.50%.

C 7.27%.

18 Based on Kowalski's assumptions and Exhibits 2 and 3, the credit spread on the VraiRive bond is *closest* to:

A 0.6949%.

B 0.9388%.

C 1.4082%.

19 The *most appropriate* response to Kowalski's question relating to the credit spread is:

A an increase in the hazard rate.

B an increase in the loss given default.

C a decrease in the risk-neutral probability of default.

20 Which of Kowalski's statements regarding the term structure of credit spreads is correct?

A Only Statement 1

B Only Statement 2

C Both Statement 1 and Statement 2

21 DLL's credit spread term structure is *most* consistent with the firm having:

A low leverage.

B weak cash flow.

C a low profit margin.

22 Given the description of the asset pool of the ABS, Kowalski should recommend a:

A loan-by-loan approach.

B portfolio-based approach.

C statistics-based approach.

The following information relates to Questions 23–30

Lena Liecken is a senior bond analyst at Taurus Investment Management. Kristel Kreming, a junior analyst, works for Liecken in helping conduct fixed-income research for the firm's portfolio managers. Liecken and Kreming meet to discuss several bond positions held in the firm's portfolios.

Bonds I and II both have a maturity of one year, an annual coupon rate of 5%, and a market price equal to par value. The risk-free rate is 3%. Historical default experiences of bonds comparable to Bonds I and II are presented in Exhibit 1.

Exhibit 1 Credit Risk Information for Comparable Bonds

Bond	Recovery Rate	Percentage of Bonds That Survive and Make Full Payment
I	40%	98%
II	35%	99%

Bond III

Bond III is a zero-coupon bond with three years to maturity. Liecken evaluates similar bonds and estimates a recovery rate of 38% and a risk-neutral default probability of 2%, assuming conditional probabilities of default. Kreming creates Exhibit 2 to compute Bond III's credit valuation adjustment. She assumes a flat yield curve at 3%, with exposure, recovery, and loss given default values expressed per 100 of par value.

Exhibit 2 Analysis of Bond III

Date	Exposure	Recovery	Loss Given Default	Probability of Default	Probability of Survival	Expected Loss	Present Value of Expected Loss
0							
1	94.2596	35.8186	58.4410	2.0000%	98.0000%	1.1688	1.1348
2	97.0874	36.8932	60.1942	1.9600%	96.0400%	1.1798	1.1121
3	100.0000	38.0000	62.0000	1.9208%	94.1192%	1.1909	1.0898
Sum				5.8808%		3.5395	3.3367

Bond IV

Bond IV is an AA rated bond that matures in five years, has a coupon rate of 6%, and a modified duration of 4.2. Liecken is concerned about whether this bond will be downgraded to an A rating, but she does not expect the bond to default during the next year. Kreming constructs a partial transition matrix, which is presented in Exhibit 3, and suggests using a model to predict the rating change of Bond IV using leverage ratios, return on assets, and macroeconomic variables.

Exhibit 3 Partial One-Year Corporate Transition Matrix (entries in %)

From/To	AAA	AA	A
AAA	92.00	6.00	1.00
AA	2.00	89.00	8.00
A	0.05	1.00	85.00
Credit Spread (%)	0.50	1.00	1.75

Default Probabilities

Kreming calculates the risk-neutral probabilities, compares them with the actual default probabilities of bonds evaluated over the past 10 years, and observes that the actual and risk-neutral probabilities differ. She makes two observations regarding the comparison of these probabilities:

Observation 1	Actual default probabilities include the default risk premium associated with the uncertainty in the timing of the possible default loss.
Observation 2	The observed spread over the yield on a risk-free bond in practice includes liquidity and tax considerations, in addition to credit risk.

23 The expected exposure to default loss for Bond I is:

A less than the expected exposure for Bond II.

B the same as the expected exposure for Bond II.

C greater than the expected exposure for Bond II.

24 Based on Exhibit 1, the loss given default for Bond II is:

A less than that for Bond I.

B the same as that for Bond I.

C greater than that for Bond I.

25 Based on Exhibit 1, the expected future value of Bond I at maturity is *closest* to:

A 98.80.

B 103.74.

C 105.00.

26 Based on Exhibit 1, the risk-neutral default probability for Bond I is *closest* to:

A 2.000%.

B 3.175%.

C 4.762%.

27 Based on Exhibit 2, the credit valuation adjustment (CVA) for Bond III is *closest* to:

A 3.3367.

B 3.5395.

C 5.8808.

28 Based on Exhibit 3, if Bond IV's credit rating changes during the next year to an A rating, its expected price change would be *closest* to:

A –8.00%.

B –7.35%.

C –3.15%.

29 Kreming's suggested model for Bond IV is a:

A structural model.

B reduced-form model.

C term structure model.

30 Which of Kreming's observations regarding actual and risk-neutral default probabilities is correct?

A Only Observation 1

B Only Observation 2

C Both Observation 1 and Observation 2

SOLUTIONS

1 B is correct. The following table shows that the credit valuation adjustment (CVA) for the bond is €36.49, the sum of the present values of expected loss. The steps taken to complete the table are as follows.

Step 1 Exposure at Date T is $\frac{€1{,}000}{(1+r)^{4-T}}$, where r is 3%. That is, exposure is computed by discounting the face value of the bond using the risk-free rate and the number of years until maturity.

Step 2 Recovery = Exposure × Recovery rate

Step 3 Loss given default (LGD) = Exposure – Recovery

Step 4 Probability of default (POD) on Date 1 is 1.50%, the assumed hazard rate. The probability of survival (POS) on Date 1 is 98.50%.

For subsequent dates, POD is calculated as the hazard rate multiplied by the previous date's POS.

For example, to determine the Date 2 POD (1.4775%), the hazard rate of (1.50%) is multiplied by the Date 1 POS (98.50%).

Step 5 POS in Dates 2–4 = POS in the previous year – POD

(That is, POS in Year T = POS in year $[T-1]$ – POD in Year T.)

POS can also be determined by subtracting the hazard rate from 100% and raising it to the power of the number of years:

$(100\% - 1.5000\%)^1 = 98.5000\%$

$(100\% - 1.5000\%)^2 = 97.0225\%$

$(100\% - 1.5000\%)^3 = 95.5672\%$

$(100\% - 1.5000\%)^4 = 94.1337\%$

Step 6 Expected loss = LGD × POD

Step 7 Discount factor (DF) for Date T is $\frac{1}{(1+r)^T}$, where r is 3%.

Step 8 PV of expected loss = Expected loss × DF

Date	Exposure	Recovery	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0								
1	€915.14	€274.54	€640.60	1.5000%	98.5000%	€9.61	0.970874	€9.33
2	€942.60	€282.78	€659.82	1.4775%	97.0225%	€9.75	0.942596	€9.19
3	€970.87	€291.26	€679.61	1.4553%	95.5672%	€9.89	0.915142	€9.05
4	€1,000.00	€300.00	€700.00	1.4335%	94.1337%	€10.03	0.888487	€8.92
							CVA =	€36.49

Value of the bond if the bond were default free would be 1,000 × DF for Date 4 = €888.49.

Fair value of the bond considering CVA = €888.49 – CVA = €888.49 – €36.49 = €852.00.

Because the market price of the bond (€875) is greater than the fair value of €852, B is correct.

A is incorrect because the market price of the bond differs from its fair value. C is incorrect because although the bond's value if the bond were default free is greater than the market price, the bond has a risk of default, and CVA lowers its fair value to below the market price.

2 B is correct. The recovery rate to be used now in the computation of fair value is 30% × 1.25 = 37.5%, whereas the hazard rate to be used is 1.50% × 1.25 = 1.875%.

Using the steps outlined in the solution to Question 1, the following table is prepared, which shows that the bond's CVA increases to 40.49. Thus, Koning concludes that a change in the probability of default has a greater effect on fair value than a similar change in the recovery rate. The steps taken to complete the table are the same as those in the previous problem. There are no changes in exposures and discount factors in this table.

Date	Exposure	Recovery	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0								
1	€915.14	€343.18	€571.96	1.8750%	98.1250%	€10.72	0.970874	€10.41
2	€942.60	€353.47	€589.12	1.8398%	96.2852%	€10.84	0.942596	€10.22
3	€970.87	€364.08	€606.80	1.8053%	94.4798%	€10.95	0.915142	€10.03
4	€1,000.00	€375.00	€625.00	1.7715%	92.7083%	€11.07	0.888487	€9.84
							CVA =	€40.49

Changes in the hazard and recovery rates do not affect the value of the default-free bond. So, it is the same as in the previous question: €888.49.

Fair value of the bond considering CVA = €888.49 − CVA = €888.49 − €40.49 = €848.00

3 A is correct. The following table shows that the CVA for the bond is €42.17, the sum of the present values of expected loss. The steps taken to complete the table are as follows.

Step 1 Exposure at Date 4 is €1,000 + Coupon amount = €1,000 + €60 = €1,060. Exposure at a date T prior to that is Coupon on Date T + PV at Date T of subsequent coupons + PV of €1,000 to be received at Date 4. For example, exposure at Date 2 is

$$€60 + \frac{€60}{1+0.03} + \frac{€60}{(1+0.03)^2} + \frac{€1{,}000}{(1+0.03)^2} = €60 + \frac{€60}{1+0.03} + \frac{€1{,}060}{(1+0.03)^2}$$
$$= €1{,}117.40$$

Steps 2 through 8 are the same as those in the solution to Question 1.

Date	Exposure	Recovery	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0								
1	€1,144.86	€343.46	€801.40	1.5000%	98.5000%	€12.02	0.970874	€11.67
2	€1,117.40	€335.22	€782.18	1.4775%	97.0225%	€11.56	0.942596	€10.89
3	€1,089.13	€326.74	€762.39	1.4553%	95.5672%	€11.10	0.915142	€10.15
4	€1,060.00	€318.00	€742.00	1.4335%	94.1337%	€10.64	0.888487	€9.45
							CVA =	€42.17

Value of the bond if the bond were default free would be €60 × DF_1 + €60 × DF_2 + €60 × DF_3 + €1,060 × DF_4 = €1,111.51.

Fair value of the bond considering CVA = €1,111.51 – €42.17 = €1,069.34

4 A is correct. If default occurs on Date 3, the rate of return can be obtained by solving the following equation for internal rate of return (IRR):

$$€1{,}090 = \frac{€60}{1 + \text{IRR}} + \frac{€60}{(1 + \text{IRR})^2} + \frac{€326.74}{(1 + \text{IRR})^3}$$

In this equation, €60 is the amount of coupon received at Dates 1 and 2 prior to default at Date 3. The amount €326.74 is the recovery at Time 3 (from the CVA table in the solution to the previous question). The solution to the foregoing equation can be obtained using the cash flow IRR function on your calculator.

5 B is correct. For each possible transition, the expected percentage price change, computed as the product of the modified duration and the change in the spread as per Exhibit 7 of the reading, is calculated as follows:

From AA to AAA: –2.75 × (0.60% – 0.90%) = +0.83%

From AA to A: –2.75 × (1.10% – 0.90%) = –0.55%

From AA to BBB: –2.75 × (1.50% – 0.90%) = –1.65%

From AA to BB: –2.75 × (3.40% – 0.90%) = –6.88%

From AA to B: –2.75 × (6.50% – 0.90%) = –15.40%

From AA to C: –2.75 × (9.50% – 0.90%) = –23.65%

The expected percentage change in the value of the AA rated bond is computed by multiplying each expected percentage price change for a possible credit transition by its respective transition probability given in Exhibit 7 of the reading, and summing the products:

(0.0150 × 0.83%) + (0.8800 × 0%) + (0.0950 × –0.55%) + (0.0075 × –1.65%) + (0.0015 × –6.88%) + (0.0005 × –15.40%) + (0.0003 × –23.65%)= –0.0774%.

Therefore, the expected return on the bond over the next year is its YTM minus 0.0774%, assuming no default.

6 B is correct. Statement B is correct because a reduced-form credit model involves regression analysis using information generally available in the financial markets, such as the measures mentioned in the statement.

Statement A is incorrect because it is consistent with the use of a structural-form model and not a reduced-form model. It is a structural-form model that is based on the premise that a firm defaults on its debt if the value of its assets falls below its liabilities and that the probability of that event has the characteristics of an option.

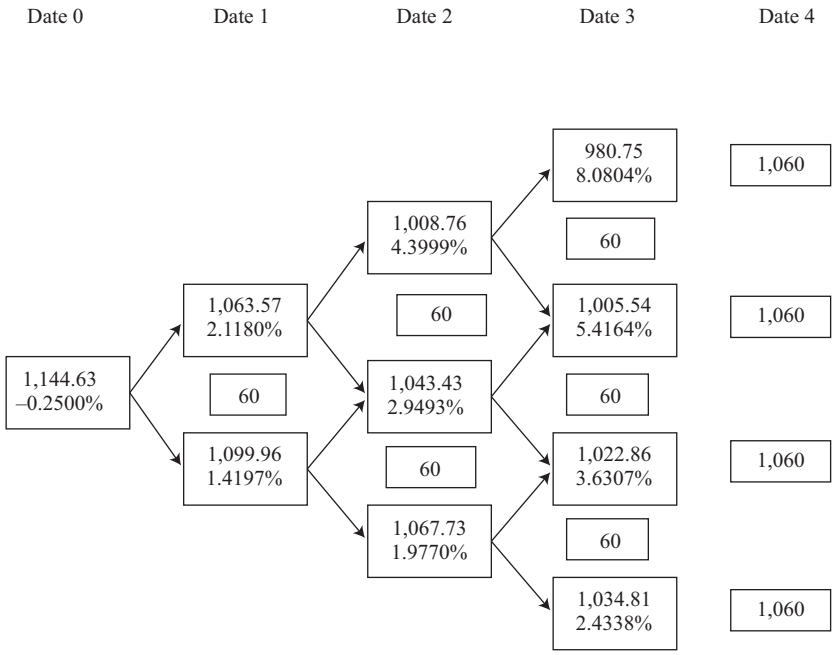
Statement C is incorrect because it is consistent with the use of a structural-form model and not a reduced-form model. A structural-form model involves the estimation of a default barrier, and default occurs if the value of firm's assets falls below the default barrier.

7 C is correct. Structural models require information best known to the managers of the company. Reduced-form models only require information generally available in financial markets

A is literally true but when when models were developed is immaterial. Structural models are currently used in practice by commercial banks and credit rating agencies.

B is incorrect because computer technology facilities valuation using option pricing models as well as regression analysis.

8 A is correct. The following tree shows the valuation assuming no default of bond B2, which pays a 6% annual coupon.



The scheduled year-end coupon and principal payments are placed to the right of each forward rate in the tree. For example, the Date 4 values are the principal plus the coupon of 60. The following are the four Date 3 values for the bond, shown above the interest rate at each node:

€1,060/1.080804 = €980.75

€1,060/1.054164 = €1,005.54

€1,060/1.036307 = €1,022.86

€1,060/1.024338 = €1,034.81

These are the three Date 2 values:

$$\frac{(0.5 \times €980.75 + 0.5 \times €1{,}005.54) + €60}{1.043999} = €1{,}008.76$$

$$\frac{(0.5 \times €1{,}005.54 + 0.5 \times €1{,}022.86) + €60}{1.029493} = €1{,}043.43$$

$$\frac{(0.5 \times €1{,}022.86 + 0.5 \times €1{,}034.81) + €60}{1.019770} = €1{,}067.73$$

These are the two Date 1 values:

$$\frac{(0.5 \times €1{,}008.76 + 0.5 \times €1{,}043.43) + €60}{1.021180} = €1{,}063.57$$

$$\frac{(0.5 \times €1{,}043.43 + 0.5 \times €1{,}067.73) + €60}{1.014197} = €1{,}099.96$$

This is the Date 0 value:

$$\frac{(0.5 \times €1{,}063.57 + 0.5 \times €1{,}099.96) + €60}{0.997500} = €1{,}144.63$$

So, the value of the bond assuming no default (VND) is 1,144.63. This value could also have been obtained more directly using the benchmark discount factors from Exhibit 2:

€60 × 1.002506 + €60 × 0.985093 + €60 × 0.955848 + €1,060 × 0.913225 = €1,144.63.

The benefit of using the binomial interest rate tree to obtain the VND is that the same tree is used to calculate the expected exposure to default loss.

The credit valuation adjustment table is now prepared following these steps:

Step 1 Compute the expected exposures as described in the following, using the binomial interest rate tree prepared earlier.

The expected exposure for Date 4 is €1,060.

The expected exposure for Date 3 is

[(0.1250 × €980.75) + (0.3750 × €1,005.54) + (0.3750 × €1,022.86) + (0.1250 × €1,034.81)] + 60 = €1,072.60.

The expected exposure for Date 2 is

[(0.25 × €1,008.76) + (0.50 × €1,043.43) + (0.25 × €1,067.73)] + €60 = €1,100.84.

The expected exposure for Date 1 is

[(0.50 × €1,063.57) + (0.50 × €1,099.96)] + 60 = €1,141.76.

Step 2 LGD = Exposure × (1 − Recovery rate)

Step 3 The initial POD, also known as the hazard rate, is provided as 1.50%. For subsequent dates, POD is calculated as the hazard rate multiplied by the previous dates' POS.

For example, to determine the Date 2 POD (1.4775%), the hazard rate (1.5000%) is multiplied by the Date 1 POS (98.5000%).

Step 4 POS is determined by subtracting the hazard rate from 100% and raising it to the power of the number of years:

$(100\% - 1.5000\%)^1 = 98.5000\%$

$(100\% - 1.5000\%)^2 = 97.0225\%$

$(100\% - 1.5000\%)^3 = 95.5672\%$

$(100\% - 1.5000\%)^4 = 94.1337\%$

Step 5 Expected loss = LGD × POD

Step 6 Discount factors (DF) in Year T are obtained from Exhibit 2.

Step 7 PV of expected loss = Expected loss × DF

Date	Exposure	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0							
1	€1,141.76	€799.23	1.5000%	98.5000%	€11.99	1.002506	€12.02
2	€1,100.84	€770.58	1.4775%	97.0225%	€11.39	0.985093	€11.22
3	€1,072.60	€750.82	1.4553%	95.5672%	€10.93	0.955848	€10.44
4	€1,060.00	€742.00	1.4335%	94.1337%	€10.64	0.913225	€9.71
						CVA =	€43.39

Fair value of the bond considering CVA = €1,144.63 – CVA = €1,144.63 – €43.39 = €1,101.24.

9 A is correct. The corporate bond's fair value is computed in the solution to Question 8 as €1,101.24 The YTM can be obtained by solving the following equation for IRR:

$$€1{,}101.24 = \frac{€60}{1+\text{IRR}} + \frac{€60}{(1+\text{IRR})^2} + \frac{€60}{(1+\text{IRR})^3} + \frac{€1{,}060}{(1+\text{IRR})^4}$$

The solution to this equation is 3.26%.

Valuation of a four-year, 6% coupon bond under no default (VND) is computed in the solution to Question 8 as 1,144.63. So, the YTM of a theoretical comparable-maturity government bond with the same coupon rate as the corporate bond B2 can be obtained by solving the following equation for IRR:

$$€1{,}144.63 = \frac{€60}{1+\text{IRR}} + \frac{€60}{(1+\text{IRR})^2} + \frac{€60}{(1+\text{IRR})^3} + \frac{€1{,}060}{(1+\text{IRR})^4}$$

The solution to this equation is 2.18%. So, the credit spread that the analyst wants to compute is 3.26% – 2.18% = 1.08%, or 108 bps.

B is incorrect, because that is the spread over the four-year government par bond that has a YTM of 2.25% in Exhibit 2: 3.26% – 2.25% = 1.01%, or 101 bps. Although this spread is commonly used in practice, the analyst is interested in finding the spread over a theoretical 6% coupon government bond.

C is incorrect, because that is the YTM of the coupon four-year government bond in Exhibit 2.

10 B is correct. The recovery rate to be used now in the computation of fair value is 30% × 0.75 = 22.500%, whereas the hazard rate to be used is 1.50% × 0.75 = 1.125%.

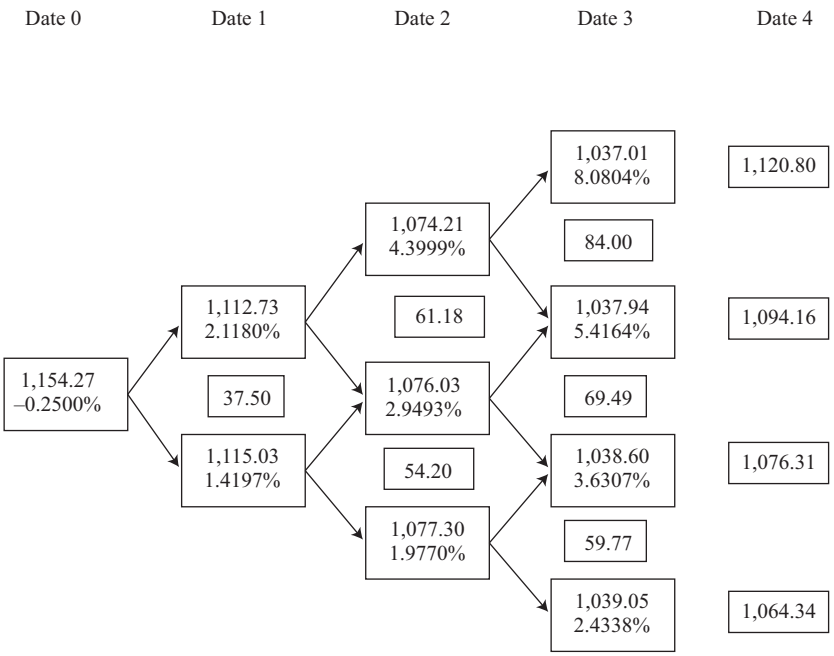
The tree that shows the valuation assuming no default of bond B2 in the solution to Question 8 will not be affected by the foregoing changes. Accordingly, VND remains €1,144.63.

Following the steps outlined in the solution to Question 8, the following table is prepared, which shows that the CVA for the bond decreases to €36.23. Thus, Ibarra concludes that a decrease in the probability of default has a greater effect on fair value than a similar decrease in the recovery rate. The steps taken to complete the table are the same as those in Question 8. There are no changes in exposures or discount factors in this table.

Date	Exposure	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0							
1	€1,141.76	€884.87	1.1250%	98.8750%	€9.95	1.002506	€9.98
2	€1,100.84	€853.15	1.1123%	97.7627%	€9.49	0.985093	€9.35
3	€1,072.60	€831.26	1.0998%	96.6628%	€9.14	0.955848	€8.74
4	€1,060.00	€821.50	1.0875%	95.5754%	€8.93	0.913225	€8.16
						CVA =	€36.23

Fair value of the bond considering CVA = €1,144.63 – CVA = €1,144.63 – €36.23 = €1,108.40

11 A is correct. The following tree shows the valuation assuming no default of floating-rate note (FRN) B4, which has a quoted margin of 4%.



The scheduled year-end coupon and principal payments are placed to the right of each forward rate in the tree. For example, the four Date 4 values are the principal plus the coupon.

€1,000 × (1 + 0.080804 + 0.04) = €1,120.80

€1,000 × (1 + 0.054164 + 0.04) = €1,094.16

€1,000 × (1 + 0.036307 + 0.04) = €1,076.31

€1,000 × (1 + 0.024338 + 0.04) = €1,064.34

The following are the four Date 3 bond values for the note, shown above the interest rate at each node:

€1,120.80/1.080804 = €1,037.01

€1,094.16/1.054164 = €1,037.94

€1,076.31/1.036307 = €1,038.60

€1,064.34/1.024338 = €1,039.05

The three Date 3 coupon amounts are computed based on the interest rate at Date 2 plus the quoted margin of 4%:

€1,000 × (0.043999 + 0.04) = €84.00

€1,000 × (0.029493 + 0.04) = €69.49

€1,000 × (0.019770 + 0.04) = €59.77

There are three Date 2 bond values:

$$\frac{\left(0.5 \times €1{,}037.01 + 0.5 \times €1{,}037.94\right) + €84.00}{1.043999} = €1{,}074.21$$

$$\frac{\left(0.5 \times €1{,}037.94 + 0.5 \times €1{,}038.60\right) + €69.49}{1.029493} = €1{,}076.03$$

$$\frac{(0.5 \times €1{,}038.60 + 0.5 \times €1{,}039.05) + €59.77}{1.019770} = €1{,}077.30$$

The two Date 2 coupon amounts are computed based on the interest rate at Date 1 plus the quoted margin of 4%:

€1,000 × (0.021180 + 0.04) = €61.18

€1,000 × (0.014197 + 0.04) = €54.20

The Date 1 coupon amount is computed based on the interest rate at Date 0 plus the quoted margin of 4%:

€1,000 × (−0.0025 + 0.04) = €37.50

These are the calculations for the bond values for Date 1 and Date 0:

$$\frac{(0.5 \times €1{,}074.21 + 0.5 \times €1{,}076.03) + €61.18}{1.021180} = €1{,}112.73$$

$$\frac{(0.5 \times €1{,}076.06 + 0.5 \times €1{,}077.30) + €54.20}{1.014197} = €1{,}115.0$$

Then, the VND is calculated as follows:

$$\frac{(0.5 \times €1{,}112.73 + 0.5 \times €1{,}115.03) + €37.50}{0.9975} = €1{,}154.27$$

The expected exposures are then computed using the binomial interest rate tree prepared earlier. For example, the expected exposure for Date 4 is computed as follows:

[(0.125 × €1,120.80) + (0.375 × €1,094.16) + (0.375 × €1,076.31) + (0.125 × €1,064.34)] = €1,087.07

Similarly, the expected exposure for Date 3 is computed as follows:

[(0.125 × €1,037.01) + (0.375 × €1,037.94) + (0.375 × €1,038.60) + (0.125 × €1,039.05)] + [(0.250 × €84) + (0.500 × €69.49) + (0.250 × €59.77)] = €1,108.90

The expected exposures for Dates 2 and 1 are computed similarly, and the credit valuation adjustment table is completed following Steps 2–7 outlined in the solution to Question 8.

Date	Exposure	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0							
1	€1,151.38	€805.97	1.5000%	98.5000%	€12.09	1.002506	€12.12
2	€1,133.58	€793.51	1.4775%	97.0225%	€11.72	0.985093	€11.55
3	€1,108.90	€776.23	1.4553%	95.5672%	€11.30	0.955848	€10.80
4	€1,087.07	€760.95	1.4335%	94.1337%	€10.91	0.913225	€9.96
						CVA =	€44.43

Fair value of the FRN considering CVA = €1,154.27 − CVA = €1,154.27 − €44.43 = €1,109.84

Because the market price of €1,070 is less than the estimated fair value, the analyst should recommend adding to existing positions in the FRN.

B and C are incorrect because the FRN is perceived to be undervalued in the market.

12 A is correct. The changing probability of default will not affect the binomial tree prepared in the solution to Question 11. The Date 1 value remains €1,154.27, which is also the VND. The expected exposures, loss given default, and discount factors are also unaffected by the changing probability of default. The following is the completed credit valuation adjustment table.

Date	Exposure	LGD	POD	POS	Expected Loss	DF	PV of Expected Loss
0							
1	€1,151.38	€805.97	1.5000%	98.5000%	€12.09	1.002506	€12.12
2	€1,133.58	€793.51	0.4925%	98.0075%	€3.91	0.985093	€3.85
3	€1,108.90	€776.23	0.4900%	97.5175%	€3.80	0.955848	€3.64
4	€1,087.07	€760.95	0.4876%	97.0299%	€3.71	0.913225	€3.39
						CVA =	€22.99

Thus, CVA decreases to €22.99.

13 C is correct. The credit rating agencies typically make incremental changes as seen in a transition matrix provided in Exhibit 7 of the reading. Ibarra believes the bond to be undervalued, in that her assessment of the probability of default and the recovery rate is more optimistic than that of the agencies. Therefore, she most likely expects the credit rating agencies to put the issuer on a positive watch.

A is incorrect because the bond is perceived to be undervalued, not overvalued. Ibarra is not expecting a credit downgrade.

B is incorrect because it is not the *most likely* expectation. The rating agencies rarely jump an issuer all the way from BBB to AAA. In Exhibit 7, the probability of a BBB rated issuer going from BBB to AAA is 0.02%, whereas it is 4.80% to go from BBB to A.

14 A is correct.

B is incorrect because, although generally true for investment-grade bonds, the statement neglects the fact that high-yield issuers sometimes face a downward-sloping credit term structure. Credit term structures are not *always* upward sloping.

C is incorrect because there is a consistent pattern to the term structure of credit spreads—typically it is upwardly sloped because greater time to maturity is associated with higher projected probabilities of default and lower recovery rates.

15 C is correct. A covered bond is a senior debt obligation of a financial institution that gives recourse to the originator/issuer as well as a predetermined underlying collateral pool. Each specific country or jurisdiction specifies the eligible collateral types as well as the specific structures permissible in the covered bond market. Covered bonds most frequently have either commercial or residential mortgages meeting specific criteria or public sector exposures as underlying collateral.

A is incorrect. The term "covered" is used in foreign exchange analysis, for instance, "covered interest rate parity." In the context of securitized debt, a covered bond is secured by specific assets in addition to the overall balance sheet of the issuer.

B is incorrect because a covered bond does not involve a credit default swap. In addition, an issuer is not likely to sell a credit default swap on its own liability.

16 A is correct. Credit spread migration typically reduces the expected return for two reasons. First, the probabilities for rating changes are not symmetrically distributed around the current rating; they are skewed toward a downgrade rather than an upgrade. Second, the increase in the credit spread is much larger for downgrades than is the decrease in the spread for upgrades.

17 A is correct. The expected return on the Entre Corp. bond over the next year is its yield to maturity plus the expected percentage price change in the bond over the next year. In the table below, for each possible transition, the expected percentage price change is the product of the bond's modified duration of 7.54, multiplied by –1, and the change in the spread, weighted by the given probability:

$$\begin{aligned}\text{Expected percentage price change} = {} & (0.0002 \times 6.786\%) + (0.0030 \times 4.524\%) + (0.0480 \times 3.016\%) + \\ & (0.8573 \times 0.000\%) + (0.0695 \times -14.326\%) + (0.0175 \times -37.700\%) + \\ & (0.0045 \times -60.320\%) \\ = {} & -1.76715\%.\end{aligned}$$

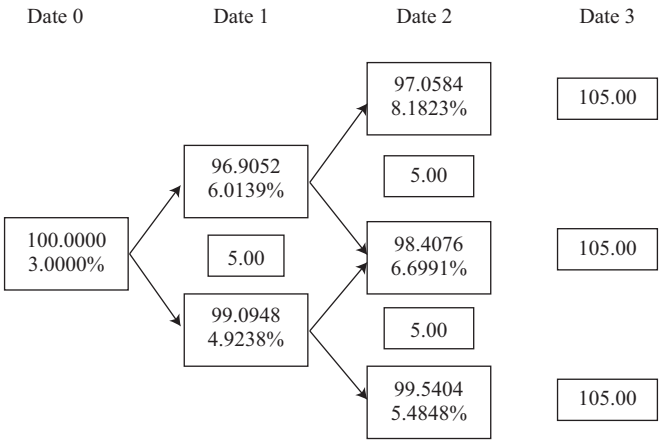
So, the expected return on the Entre Corp. bond is its yield to maturity plus the expected percentage price change due to credit migration:

Expected return = 5.50% – 1.77% = 3.73%.

	Expected % Price Change (1)	Probability (2)	Expected % Price Change × Probability (1 × 2)
From BBB to AAA	–7.54 × (0.60% – 1.50%) = 6.786%	0.0002	0.00136
From BBB to AA	–7.54 × (0.90% – 1.50%) = 4.524%	0.0030	0.01357
From BBB to A	–7.54 × (1.10% – 1.50%) = 3.016%	0.0480	0.14477
From BBB to BB	–7.54 × (3.40% – 1.50%) = –14.326%	0.0695	–0.99566
From BBB to B	–7.54 × (6.50% – 1.50%) = –37.700%	0.0175	–0.65975
From BBB to CCC, CC, C	–7.54 × (9.50% – 1.50%) = –60.320%	0.0045	–0.27144
		Total:	–1.76715

18 C is correct. The credit spread can be calculated in three steps:

Step 1 Estimate the value of the three-year VraiRive bond assuming no default. Based on Kowalski's assumptions and Exhibits 2 and 3, the value of the three-year VraiRive bond assuming no default is 100.0000.



Supporting calculations:

The bond value in each node is the value of next period's cash flows discounted by the forward rate. For the three nodes on Date 2, the bond values are as follows:

105/1.081823 = 97.0584.

105/1.066991 = 98.4076.

105/1.054848 = 99.5404.

For the two nodes on Date 1, the two bond values are as follows:

[0.5 × (97.0584) + 0.5 × (98.4076) + 5.00]/1.060139 = 96.9052.

[0.5 × (98.4076) + 0.5 × (99.5404) + 5.00]/1.049238 = 99.0948.

Finally, for the node on Date 0, the bond value is

[0.5 × (96.9052) + 0.5 × (99.0948) + 5.00]/1.030000 = 100.0000.

Therefore, the VND for the VraiRive bond is 100.0000.

Step 2 Calculate the credit valuation adjustment (CVA), and then subtract the CVA from the VND from Step 1 to establish the fair value of the bond. The CVA equals the sum of the present values of each year's expected loss and is calculated as follows:

Date	Expected Exposure	Loss Given Default	Probability of Default	Discount Factor	Present Value of Expected Loss
1	103.0000	68.6667	2.0000%	0.970874	1.3333
2	103.3535	68.9023	1.9600%	0.920560	1.2432
3	105.0000	70.0000	1.9208%	0.862314	1.1594
				CVA =	3.7360

Supporting calculations:

The expected exposures at each date are the bond values at each node, weighted by their risk-neutral probabilities, plus the coupon payment:

Date 1: 0.5 × (96.9052) + 0.5 × (99.0948) + 5.00 = 103.0000.

Date 2: 0.25 × (97.0584) + 0.5 × (98.4076) + 0.25 × (99.5404) + 5.00 = 103.3535.

Date 3: 105.0000

The loss given default (LGD) on each date is 2/3 of the expected exposure.

The probability of default (POD) on each date is as follows:

Date 1: 2%

Date 2: 2% × (100% – 2%) = 1.96%.

Date 3: 2% × $(100\% - 2\%)^2$ = 1.9208%.

The discount factor on each date is 1/(1 + spot rate for the date) raised to the correct power.

Finally, the credit valuation adjustment each year is the product of the LGD times the POD times the discount factor, as shown in the last column of the table. The sum of the three annual CVAs is 3.7360.

So, the fair value of the VraiRive bond is the VND less the CVA, or VND – CVA = 100 – 3.7360 = 96.2640.

Step 3 Based on the fair value from Step 2, calculate the yield to maturity of the bond, and solve for the credit spread by subtracting the yield to maturity on the benchmark bond from the yield to maturity on the VraiRive bond. The credit spread is equal to the yield to maturity on the VraiRive bond minus the yield to maturity on the three-year benchmark bond (which is 5.0000%). Based on its fair value of 96.2640, the VraiRive bond's yield to maturity (YTM) is

$$96.2640 = \frac{5}{(1 + \text{YTM})} + \frac{5}{(1 + \text{YTM})^2} + \frac{105}{(1 + \text{YTM})^3}$$

Solving for YTM, the yield to maturity is 6.4082%. Therefore, the credit spread on the VraiRive bond is 6.4082% – 5.0000% = 1.4082%.

19 C is correct. A decrease in the risk-neutral probability of default would decrease the credit valuation adjustment and decrease the credit spread. In contrast, increasing the bond's loss-given-default assumption and increasing the probability-of-default (hazard rate) assumption would increase the credit valuation adjustment and decrease the fair value of the bond (and increase the yield to maturity and the credit spread over its benchmark).

20 A is correct. For investment-grade bonds with the highest credit ratings, credit spreads are extremely low, and credit migration is possible only in one direction given the implied lower bound of zero on credit spreads. As a result, the credit term structure for the most highly rated securities tends to be either flat or slightly upward sloping. Securities with lower credit quality, however, face greater sensitivity to the credit cycle. Credit spreads would decrease, not increase, with the expectation of economic growth. There is a countercyclical relationship between credit spreads and benchmark rates over the business cycle. A strong economic climate is associated with higher benchmark yields but lower credit spreads because the probability of issuers defaulting declines in such good times.

21 A is correct. Positively sloped credit spread curves may arise when a high-quality issuer with a strong competitive position in a stable industry has low leverage, strong cash flow, and a high profit margin. This type of issuer tends to exhibit very low short-term credit spreads that rise with increasing maturity given greater uncertainty due to the macroeconomic environment, potential adverse changes in the competitive landscape, technological change, or other

factors that drive a higher implied probability of default over time. Empirical academic studies also tend to support the view that the credit spread term structure is upward sloping for investment-grade bond portfolios.

22 B is correct. The auto ABS is granular, with many small loans relative to the size of the total portfolio. The auto loans are also homogeneous. These characteristics support using the portfolio-based approach. A loan-by-loan approach would be inefficient because of the large number of basically similar loans; this approach is best for a portfolio of discrete, large loans that are heterogeneous. A statistics-based approach would work for a static book of loans, whereas the auto loan portfolio would be dynamic and would change over time.

23 B is correct. The expected exposure is the projected amount of money that an investor could lose if an event of default occurs, before factoring in possible recovery. The expected exposure for both Bond I and Bond II is 100 + 5 = 105.

24 C is correct. The loss given default is a positive function of the expected exposure to default loss and a negative function of the recovery rate. Because Bond II has a lower recovery rate than Bond I and the same expected exposure to default loss (100 + 5 = 105), it will have a higher loss given default than Bond I will have. The loss given default for Bond I is 105 × (1 − 0.40) = 63.00. The loss given default for Bond II is 105 × (1 − 0.35) = 68.25.

25 B is correct. In the event of no default, the investor is expected to receive 105. In the event of a default, the investor is expected to receive 105 − [105 × (1 − 0.40)] = 42. The expected future value of the bond is, therefore, the weighted average of the no-default and default amounts, or (105 × 0.98) + (42 × 0.02) = 103.74.

26 B is correct. The risk-neutral default probability, P^*, is calculated using the current price, the expected receipt at maturity with no default (that is, 100 + 5 = 105), the expected receipt at maturity in the event of a default (that is, 0.40 × 105 = 42), and the risk-free rate of interest (0.03):

$$100 = \frac{\left[105 \times \left(1 - P^*\right)\right] + \left(42 \times P^*\right)}{1.03}$$

Solving for P^* gives 0.031746, or 3.1746%.

27 A is correct. The CVA is the sum of the present value of expected losses on the bond, which from Exhibit 2 is 3.3367.

28 C is correct. The expected percentage price change is the product of the negative of the modified duration and the difference between the credit spread in the new rating and the old rating:

Expected percentage price change = −4.2 × (0.0175 − 0.01) = −0.0315, or −3.15%.

29 B is correct. A reduced-form model in credit risk analysis uses historical variables, such as financial ratios and macroeconomic variables, to estimate the default intensity. A structural model for credit risk analysis, in contrast, uses option pricing and relies on a traded market for the issuer's equity.

30 B is correct. Observation 1 is incorrect, but Observation 2 is correct. The actual default probabilities do not include the default risk premium associated with the uncertainty in the timing of the possible default loss. The observed spread over the yield on a risk-free bond in practice does include liquidity and tax considerations, in addition to credit risk.

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PRACTICE PROBLEMS

The following information relates to Questions 1–6

UNAB Corporation

On 1 January 20X2, Deem Advisors purchased a $10 million six-year senior unsecured bond issued by UNAB Corporation. Six months later (1 July 20X2), concerned about the portfolio's credit exposure to UNAB, Doris Morrison, the chief investment officer at Deem Advisors, purchases a $10 million CDS with a standardized coupon rate of 5%. The reference obligation of the CDS is the UNAB bond owned by Deem Advisors.

On 1 January 20X3, Morrison asks Bill Watt, a derivatives analyst, to assess the current credit quality of UNAB bonds and the value of Deem Advisor's CDS on UNAB debt. Watt gathers the following information on the UNAB's debt issues currently trading in the market:

Bond 1: A two-year senior unsecured bond trading at 40% of par

Bond 2: A six-year senior unsecured bond trading at 50% of par

Bond 3: A six-year subordinated unsecured bond trading at 20% of par

With respect to the credit quality of UNAB, Watt makes the following statement:

> "There is severe near-term stress in the financial markets and UNAB's credit curve clearly reflects the difficult environment."

On 1 July 20X3, UNAB fails to make a scheduled interest payment on the outstanding subordinated unsecured obligation after a grace period; however, the company does not file for bankruptcy. Morrison asks Watt to determine if UNAB experienced a credit event and, if so, to recommend a settlement preference.

Kand Corporation

Morrison is considering purchasing a 10-year CDS on Kand Corporation debt to hedge its current portfolio position. She instructs Watt to determine if an upfront payment would be required and, if so, the amount of the premium. Watt presents the information for the CDS in Exhibit 1.

Exhibit 1 Summary Data for 10-year CDS on Kand Corporation

Credit spread	700 basis points
Duration	7 years
Coupon rate	5%

Morrison purchases the 10-year CDS on Kand Corporation debt. Two months later the credit spread for Kand Corp. has increased by 200 basis points. Morrison asks Watt to close out the firm's CDS position on Kand Corporation by entering into new offsetting contracts.

Tollunt Corporation

Deem Advisors' chief credit analyst recently reported that Tollunt Corporation's five-year bond is currently yielding 7% and a comparable CDS contract has a credit spread of 4.25%. Since Libor is 2.5%, Watt has recommended executing a basis trade to take advantage of the pricing of the Tollunt's bonds and CDS. The basis trade would consist of purchasing both the bond and the CDS contract.

1 If UNAB experienced a credit event on 1 July, Watt should recommend that Deem Advisors:
   - **A** prefer a cash settlement.
   - **B** prefer a physical settlement.
   - **C** be indifferent between a cash or a physical settlement.

2 According to Watt's statement, the shape of UNAB's credit curve is *most likely*:
   - **A** flat.
   - **B** upward-sloping.
   - **C** downward-sloping.

3 Should Watt conclude that UNAB experienced a credit event?
   - **A** Yes.
   - **B** No, because UNAB did not file for bankruptcy.
   - **C** No, because the failure to pay occurred on a subordinated unsecured bond.

4 Based on Exhibit 1, the upfront premium as a percent of the notional for the CDS protection on Kand Corp. would be *closest* to:
   - **A** 2.0%.
   - **B** 9.8%.
   - **C** 14.0%.

5 If Deem Advisors enters into a new offsetting contract two months after purchasing the CDS protection on Kand Corporation, this action will *most likely* result in:
   - **A** a loss on the CDS position.
   - **B** a gain on the CDS position.
   - **C** neither a loss or a gain on the CDS position.

6 Based on basis trade for Tollunt Corporation, if convergence occurs in the bond and CDS markets, the trade will capture a profit *closest* to:
   - **A** 0.25%.
   - **B** 1.75%.
   - **C** 2.75%.

The following information relates to Questions 7–15

John Smith, a fixed-income portfolio manager at a €10 billion sovereign wealth fund (SWF), meets with Sofia Chan, a derivatives strategist with Shire Gate Securities (SGS), to discuss investment opportunities for the fund. Chan notes that SGS adheres to ISDA (International Swaps and Derivatives Association) protocols for credit default swap (CDS) transactions and that any contract must conform to ISDA specifications. Before the fund can engage in trading CDS products with SGS, the fund must satisfy compliance requirements.

Smith explains to Chan that fixed-income derivatives strategies are being contemplated for both hedging and trading purposes. Given the size and diversified nature of the fund, Smith asks Chan to recommend a type of CDS that would allow the SWF to simultaneously fully hedge multiple fixed-income exposures.

Next, Smith asks Chan to assess the impact on derivative products of recent events affecting Maxx Corporation, a US company. The SWF holds an unsecured debt instrument issued by Maxx. Chan says she is very familiar with Maxx because many of its unsecured debt obligations are commonly included in broad baskets of bonds used for hedging purposes. SGS recently sold €400 million of protection on the on-the-run CDX high yield (HY) index that includes a Maxx bond; the index contains 100 entities. Chan reports that creditors met with company executives to impose a restructuring on Maxx bonds; as a result, all outstanding principal obligations will be reduced by 30%.

Smith and Chan discuss opportunities to add trading profits to the SWF. Smith asks Chan to determine the probability of default associated with a five-year investment-grade bond issued by Orion Industrial. Selected data on the Orion Industrial bond are presented in Exhibit 1.

Exhibit 1 Selected Data on Orion Industrial Five-Year Bond

Year	Hazard Rate
1	0.22%
2	0.35%
3	0.50%
4	0.65%
5	0.80%

Chan explains that a single-name CDS can also be used to add profit to the fund over time. Chan describes a hypothetical trade in which the fund sells £6 million of five-year CDS protection on Orion, where the CDS contract has a duration of 3.9 years. Chan assumes that the fund closes the position six months later, after Orion's credit spread narrowed from 150 bps to 100 bps.

Chan discusses the mechanics of a long/short trade. In order to structure a number of potential trades, Chan and Smith exchange their respective views on individual companies and global economies. Chan and Smith agree on the following outlooks.

Outlook 1: Italy's economy will weaken.

Outlook 2: The US economy will strengthen relative to that of Canada.

Outlook 3: The credit quality of electric car manufacturers will improve relative to that of traditional car manufacturers.

Chan believes US macroeconomic data are improving and that the general economy will strengthen in the short term. Chan suggests that a curve trade could be used by the fund to capitalize on her short-term view of a steepening of the US credit curve.

Another short-term trading opportunity that Smith and Chan discuss involves the merger and acquisition market. SGS believes that Delta Corporation may make an unsolicited bid at a premium to the market price for all of the publicly traded shares of Zega, Inc. Zega's market capitalization and capital structure are comparable to Delta's; both firms are highly levered. It is anticipated that Delta will issue new equity along with 5- and 10-year senior unsecured debt to fund the acquisition, which will significantly increase its debt ratio.

7 To satisfy the compliance requirements referenced by Chan, the fund is *most likely* required to:

A set a notional amount.

B post an upfront payment.

C sign an ISDA master agreement.

8 Which type of CDS should Chan recommend to Smith?

A CDS index

B Tranche CDS

C Single-name CDS

9 Following the Maxx restructuring, the CDX HY notional will be *closest* to:

A €396.0 million.

B €398.8 million.

C $400.0 million.

10 Based on Exhibit 1, the probability of Orion defaulting on the bond during the first three years is *closest* to:

A 1.07%.

B 2.50%.

C 3.85%.

11 To close the position on the hypothetical Orion trade, the fund:

A sells protection at a higher premium than it paid at the start of the trade.

B buys protection at a lower premium than it received at the start of the trade.

C buys protection at a higher premium than it received at the start of the trade.

12 The hypothetical Orion trade generated an approximate:

A loss of £117,000.

B gain of £117,000.

C gain of £234,000.

13 Based on the three economic outlook statements, a profitable long/short trade would be to:

A go long a Canadian CDX IG and short a US CDX IG.

B short an iTraxx Crossover and go long an iTraxx Main.

C short electric car CDS and go long traditional car CDS.

14 The curve trade that would *best* capitalize on Chan's view of the US credit curve is to:

A short a 20-year CDX and short a 2-year CDX.

B short a 20-year CDX and go long a 2-year CDX.

C go long a 20-year CDX and short a 2-year CDX.

15 A profitable equity-versus-credit trade involving Delta and Zega is to:

A short Zega shares and short Delta 10-year CDS.

B go long Zega shares and short Delta 5-year CDS.

C go long Delta shares and go long Delta 5-year CDS.

SOLUTIONS

1 A is correct. Deem Advisors would prefer a cash settlement. Deem Advisors owns Bond 2 (trading at 50% of par), which is worth more than the cheapest-to-deliver obligation (Bond 1 trading at 40% of par). Deem Advisors can cash settle for $6 million [= (1 – 40%) × $10 million] on its CDS contract and sell Bond 2 it owns for $5 million, for total proceeds of $11 million. If Deem Advisors were to physically settle the contract, only $10 million would be received, the face amount of the bonds and they would deliver Bond 2.

B is incorrect because if Deem Advisors were to physically settle the contract, they would receive only $10 million, which is less than the $11 million that could be obtained from a cash settlement. C is incorrect because Deem Advisors would not be indifferent between settlement protocols as the firm would receive $1 million more with a cash settlement in comparison to a physical settlement.

2 C is correct. A downward-sloping credit curve implies a greater probability of default in the earlier years than in the later years. Downward-sloping curves are less common and often are the result of severe near-term stress in the financial markets.

A is incorrect because a flat credit curve implies a constant hazard rate (relevant probability of default). B is incorrect because an upward-sloping credit curve implies a greater probability of default in later years.

3 A is correct. UNAB experienced a credit event when it failed to make the scheduled coupon payment on the outstanding subordinated unsecured obligation. Failure to pay, a credit event, occurs when a borrower does not make a scheduled payment of principal or interest on *any* outstanding obligations after a grace period, even without a formal bankruptcy filing.

B is incorrect because a credit event can occur without filing for bankruptcy. There are three general types of credit events: bankruptcy, failure to pay, and restructuring.

C is incorrect because a credit event (failure to pay) occurs when a borrower does not make a scheduled payment of principal or interest on *any* outstanding obligations after a grace period, without a formal bankruptcy filing.

4 C is correct. An approximation for the upfront premium is the (Credit spread – Fixed coupon rate) × Duration of the CDS. To buy 10-year CDS protection, Deem Advisors would have to pay an approximate upfront premium of 1400 basis points [(700 – 500) × 7], or 14% of the notional.

A is incorrect because 200 basis points, or 2%, is derived by taking the simple difference between the credit spread and the fixed coupon rate (700 – 500). B is incorrect because 980 basis points, or 9.8%, is the result of dividing the credit spread by the fixed coupon rate and multiplying by the duration of the CDS [(700/500) × 7].

5 B is correct. Deem Advisors purchased protection, and therefore is economically short and benefits from an increase in the company's spread. Since putting on the protection, the credit spread increased by 200 basis points, and Deem Advisors realizes the gain by entering into a new offsetting contract (sells the protection for a higher premium to another party).

A is incorrect because a decrease (not increase) in the spread would result in a loss for the credit protection buyer. C is incorrect because Deem Advisors, the credit protection buyer, would profit from an increase in the company's credit spread, not break even.

6 A is correct. A difference in credit spreads in the bond market and CDS market is the foundation of the basis trade strategy. If the spread is higher in the bond market than the CDS market, it is said to be a negative basis. In this case, the bond credit spread is currently 4.50% (bond yield minus Libor) and the comparable CDS contract has a credit spread of 4.25%. The credit risk is cheap in the CDS market relative to the bond market. Since the protection and the bond were both purchased, if convergence occurs, the trade will capture the 0.25% differential in the two markets (4.50% – 4.25%).

B is incorrect because the bond market implies a 4.50% credit risk premium (bond yield minus Libor) and the CDS market implies a 4.25% credit risk premium. Convergence of the bond market credit risk premium and the CDS credit risk premium would result in capturing the differential, 0.25%. The 1.75% is derived by incorrectly subtracting Libor from the credit spread on the CDS (= 4.25% – 2.50%).

C is incorrect because convergence of the bond market credit risk premium and the CDS credit risk premium would result in capturing the differential, 0.25%. The 2.75% is derived incorrectly by subtracting the credit spread on the CDS from the current bond yield (= 7.00% – 4.25%).

7 C is correct. Parties to CDS contracts generally agree that their contracts will conform to ISDA specifications. These terms are specified in the ISDA master agreement, which the parties to a CDS sign before any transactions are made. Therefore, to satisfy the compliance requirements referenced by Chan, the sovereign wealth fund must sign an ISDA master agreement with SGS.

8 A is correct. A CDS index (e.g., CDX and iTraxx) would allow the SWF to simultaneously fully hedge multiple fixed-income exposures.

9 C is correct. When an entity within an index defaults, that entity is removed from the index and settled as a single-name CDS based on its relative proportion in the index. To qualify as a credit event, the restructuring must be involuntary and forced on the borrower by the creditors. Although the Maxx restructuring would be considered a credit event (default) in the eurozone, in the United States, restructuring is not considered a credit event; therefore, the notional amount of $400 million will not change.

10 A is correct. Based on Exhibit 1, the probability of survival for the first year is 99.78% (100% minus the 0.22% hazard rate). Similarly, the probability of survival for the second and third years is 99.65% (100% minus the 0.35% hazard rate) and 99.50% (100% minus the 0.50% hazard rate), respectively. Therefore, the probability of survival of the Orion bond through the first three years is equal to (0.9978) × (0.9965) × (0.9950) = 0.9893, and the probability of default sometime during the first three years is 1 – 0.9893, or 1.07%.

11 B is correct. The trade assumes that £6 million of five-year CDS protection on Orion is initially sold, so the fund received the premium. Because the credit spread of the Orion CDS narrowed from 150 bps to 100 bps, the CDS position will realize a financial gain. This financial gain is equal to the difference between the upfront premium received on the original CDS position and the upfront premium to be paid on a new, offsetting CDS position. To close the position and monetize this gain, the fund should unwind the position with a new offsetting CDS, thereby buying protection for a lower premium (relative to the original premium collected) in six months.

12 B is correct. The gain on the hypothetical Orion trade is £117,000, calculated as follows.

$$\begin{aligned}\text{Approximate profit} &= \text{Change in credit spread (in bps)} \times \text{Duration} \times \text{Notional amount}\\ \text{Approximate profit} &= (150 \text{ bps} - 100 \text{ bps}) \times 3.9 \times £6 \text{ million}\\ \text{Approximate profit} &= .005 \times 3.9 \times £6 \text{ million}\\ &= £117{,}000\end{aligned}$$

The SWF gains because they sold protection at a spread of 150 bps and closed out the position by buying protection at a lower spread of 100 bps.

13 B is correct. Based on Outlook 1, Chan and Smith anticipate that Italy's economy will weaken. In order to profit from this forecast, one would go short (buy protection) a high-yield Italian CDS (e.g., iTraxx Crossover) index and go long (sell protection) an investment-grade Italian CDS (e.g., iTraxx Main) index.

14 B is correct. To take advantage of Chan's view of the US credit curve steepening in the short term, a curve trade will entail shorting (buying protection) a long-term (20-year) CDX and going long (selling protection) a short-term (2-year) CDX. A steeper curve means that long-term credit risk increases relative to short-term credit risk.

15 B is correct. If Delta Corporation issues significantly more debt, it raises the probability that it may default, thereby increasing the CDS spread. The shares of Zega will be bought at a premium resulting from the unsolicited bid in the market. An equity-versus-credit trade would be to go long (buy) the Zega shares and short (buy protection) the Delta five-year CDS.

Derivatives

STUDY SESSIONS

Study Session 14 Derivatives

TOPIC LEVEL LEARNING OUTCOME

The candidate should be able to estimate the value of futures, forwards, options, and swaps and demonstrate how they may be used in various strategies.

Derivatives are used extensively to manage financial risk. Institutions and individuals use derivatives to transfer, modify, or eliminate unwanted interest rate, currency, cash flow, or market exposures. Besides their value in risk management, derivatives can also be effective tools for generating income, enhancing returns, and creating synthetic exposure. Efficiencies in cost, liquidity, ability to short, and limited capital outlay may make derivatives attractive alternatives to their underlying.

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