

PRACTICE PROBLEMS

1 Which of the following statements regarding exchange-traded funds (ETFs) is correct? ETFs:

A disclose their holdings on a quarterly basis.

B trade in both primary and secondary markets.

C offer a creation/redemption mechanism that allows any investor to create or redeem shares.

2 The list of securities that a particular ETF wants to own, which is disclosed daily by all ETFs, is referred to as the:

A creation unit.

B creation basket.

C redemption basket.

3 When an authorized participant transacts to create or redeem ETF shares, the related costs are ultimately borne:

A solely by the ETF sponsor.

B solely by the AP.

C proportionally by all existing ETF shareholders.

4 Assuming arbitrage costs are minimal, which of the following is *most likely* to occur when the share price of an ETF is trading at a premium to its intraday NAV?

A New ETF shares will be created by the ETF sponsor.

B Redemption baskets will be received by APs from the ETF sponsor.

C Retail investors will exchange baskets of securities that the ETF tracks for creation units.

5 An ETF's reported tracking error is typically measured as the:

A standard deviation of the difference in daily returns between an ETF and its benchmark.

B difference in annual return between an ETF and its benchmark over the past 12 months.

C annualized standard deviation of the difference in daily returns between an ETF and its benchmark.

6 To best assess an ETF's performance, which reflects the impact of portfolio rebalancing expenses and other fees, an investor should:

A review daily return differences between the ETF and its benchmark.

B perform a rolling return assessment between the ETF and its benchmark.

C compare the ETF's annual expense ratio with that of other ETFs in its asset class category.

7 An ETF's tracking error, as traditionally reported, indicates to investors:

A whether the ETF is underperforming or outperforming its underlying index.

B the magnitude by which an ETF's returns deviate from its benchmark over time.

C the distribution of differences in daily returns between the ETF and its benchmark.

8 For a typical ETF, which of the following sources of tracking error is *most likely* to be the smallest contributor to tracking error?

A Representative sampling

B Fees and expenses incurred by the ETF

C Changes to the underlying index securities

9 Which of the following statements relating to capital gains in ETFs and mutual funds is correct?

A ETFs tend to distribute less in capital gains than mutual funds do.

B Mutual funds may elect not to distribute all realized capital gains in a given year.

C The selling of ETF shares by some investors may create capital gains that affect the remaining ETF investors in terms of taxes.

10 Which of the following statements regarding distributions made by ETFs is correct?

A Return-of-capital (ROC) distributions are generally not taxable.

B ETFs generally reinvest any dividends received back into the ETF's holdings.

C A dividend distribution is a distribution paid to investors in excess of an ETF's earnings.

11 Such factors as regulations, competition, and corporate actions relate to:

A fund-closure risk.

B counterparty risk.

C expectation-related risk.

12 John Smith has invested in an inverse ETF. Smith is a novice investor who is not familiar with inverse ETFs, and therefore, he is unsure how the ETF will perform because of a lack of understanding of the ETF's risk and return characteristics. This risk is *best* described as:

A counterparty risk.

B holdings-based risk.

C expectation-related risk.

13 Investors buying ETFs:

A incur management fees that decrease with the length of the holding period.

B are assured of paying a price equal to the NAV if they purchase shares at the market close.

C incur trading costs in the form of commissions and bid–ask spreads at the time of purchase.

14 Consider an ETF with the following trading costs and management fees:

- Annual management fee of 0.40%
- Round-trip trading commissions of 0.55%
- Bid–offer spread of 0.20% on purchase and sale

Excluding compound effects, the expected total holding-period cost for investing in the ETF over a nine-month holding period is *closest* to:

A 1.05%.

B 1.15%.

C 1.25%.

15 The bid–ask spread for very liquid, high-volume ETFs will be *least* influenced by the:

A market maker's desired profit spread.

B creation/redemption fees and other direct costs.

C likelihood of receiving an offsetting ETF order in a short time frame.

16 Factor (smart beta) strategy ETFs are *least likely* to be used by investors:

A to modify portfolio risk.

B for tactical trading purposes.

C to seek outperformance versus a benchmark.

17 Which of the following statements regarding applications of ETFs in portfolio management is correct?

A Equity ETFs tend to be more active than fixed-income ETFs.

B The range of risk exposures available in the futures market is more diverse than that available in the ETF space.

C ETFs that have the highest trading volumes in their asset class category are generally preferred for tactical trading applications.

SOLUTIONS

1 B is correct. ETFs trade in both primary and secondary markets. The primary market for ETF trading is that which exists on an over-the-counter basis between authorized participants (APs), a special group of institutional investors, and the ETF issuer or sponsor. This process is referred to as creation/redemption, and it is only through these primary market transactions that shares of the ETF can be created or destroyed. ETFs also trade in the secondary market on exchanges. Secondary market trading happens between any pair of market participants—individual or institutional investors, market makers, and so on.

2 B is correct. Each day, ETF managers publicly disclose a list of securities that they want to own, which is referred to as the creation basket. This basket also serves as the portfolio for determining the intrinsic net asset value (NAV) of the ETF on the basis of prices during the trading day.

3 B is correct. The AP generally absorbs all the costs associated with buying or selling the securities in the baskets or the ETF shares and pays an additional fee to the ETF provider to cover processing fees associated with creation/redemption activities. APs pass these costs to investors in the ETF's bid–ask spread, which is incurred by investors entering (ETF share buyers) and exiting (ETF share sellers) the fund.

4 A is correct. When the share price of an ETF is trading at a premium to its intraday NAV and assuming arbitrage costs are minimal, APs will step in and take advantage of the arbitrage. Specifically, APs will step in and buy the basket of securities that the ETF tracks (the creation basket) and exchange it with the ETF provider for new ETF shares (a creation unit). These new shares received by APs can then be sold on the open market to realize arbitrage profits.

5 C is correct. An ETF's tracking error is typically reported as the annualized standard deviation of the daily differential returns of the ETF and its benchmark.

6 B is correct. A rolling return assessment, referred to in the ETF industry as the "tracking difference," provides a more informative picture of the investment outcome for an investor in an ETF. Such an analysis allows investors to see the cumulative effect of portfolio management and expenses over an extended period. It also allows for comparison with other annual metrics such as a fund's expense ratio. Tracking error, as a statistic, reveals only ETF tracking variability; it does not reveal to investors whether the fund is over- or underperforming its index or whether that tracking error is concentrated over a few days or is more consistently experienced. An ETF's expense ratio does not fully reflect the investor experience. That is, the expense ratio does not reflect the cost of portfolio rebalancing or other fees, making it an inferior assessment measure relative to a rolling return assessment.

7 B is correct. An ETF's tracking error is typically reported as the annualized standard deviation of the daily differential returns of the ETF and its benchmark. Therefore, an ETF's reported tracking error indicates to investors the magnitude by which an ETF's returns deviate from those of its benchmark over time.

8 C is correct. Although additions and deletions of securities from the underlying benchmark index may occur and result in tracking error, such index changes generally occur infrequently (often quarterly). In addition, ETF portfolio managers may work with APs for index rebalance trades to ensure market-on-close

pricing to minimize this source of tracking error. Therefore, the resulting tracking error caused by index changes will not likely be as large as the tracking error caused by representative sampling or by fees and expenses incurred by the ETF.

9 A is correct. ETFs tend to distribute far less in capital gains relative to mutual funds. This is mostly due to the fact that ETFs have historically had significantly lower turnover than mutual funds have had.

10 A is correct. Return-of-capital distributions are amounts paid out in excess of an ETF's earnings and serve to reduce an investor's cost basis by the amount of the distribution. These distributions are generally not taxable.

11 A is correct. Fund-closure risk is the risk that an ETF may shut down. The reasons that lead to an ETF closing down often have to do with changes in regulations, increased competition, and corporate activity (merger and acquisition activity within the ETF industry).

12 C is correct. Expectation-related risk is the risk that some ETF investors may not fully understand how more complex ETFs will perform because of a lack of understanding of sophisticated assets classes and strategies.

13 C is correct. ETF trading costs in the form of commissions and bid–ask spreads are paid by investors buying or selling ETF shares on an exchange. These trading costs are influenced by the bid–ask spread of the ETF, the size of the trade relative to the normal trading activity of the ETF, and the ease of hedging the ETF by the market-making community. Even the closing price of the ETF on the exchange includes a premium or discount to the NAV, driven by supply and demand factors on the exchange and the market impact costs of executing an exchange transaction. The purchase and sale trading costs of an ETF are paid regardless of holding period, whereas other costs, such as management fees, increase as the holding period lengthens.

14 A is correct. The expected total holding-period cost for investing in the ETF over a nine-month holding period is calculated as follows:

Total holding-period cost = Annual management fee + Round-trip trading commissions + Bid–offer spread on purchase/sale.

Total holding-period cost = (9/12) × (0.40%) + 0.55% + 0.20% = 1.05%.

15 B is correct. ETF bid–ask spreads are generally less than or equal to the combination of the following:

- ± Creation/redemption fees and other direct costs, such as brokerage and exchange fees
- + Bid–ask spread of the underlying securities held by the ETF
- + Compensation for the risk of hedging or carrying positions by liquidity providers (market makers) for the remainder of the trading day
- + Market maker's desired profit spread
- – Discount related to the likelihood of receiving an offsetting ETF order in a short time frame

For very liquid and high-volume ETFs, buyers and sellers are active throughout the trading day. Therefore, because most of these ETF trades are matched extremely quickly and never involve the creation/redemption process, the first three factors listed do not contribute heavily to their bid–ask spreads. So, creation/redemption fees and other direct costs are not likely to have much influence on these ETFs' bid–ask spreads.

16 B is correct. Factor strategy ETFs are usually benchmarked to an index created with predefined rules for screening and/or weighting stock holdings and are considered longer-term, buy-and-hold investment options rather than tactical trading instruments. The strategy index rules are structured around return drivers or factors, such as value, dividend yield, earnings or dividend growth, quality, stock volatility, or momentum. Investors using factor-based investing seek outperformance versus a benchmark or portfolio risk modification.

17 C is correct. ETFs that have the highest trading volumes in their asset class category are generally preferred for tactical trading applications.

PRACTICE PROBLEMS

1 Compare the assumptions of the arbitrage pricing theory (APT) with those of the capital asset pricing model (CAPM).

2 Last year the return on Harry Company stock was 5 percent. The portion of the return on the stock not explained by a two-factor macroeconomic factor model was 3 percent. Using the data given below, calculate Harry Company stock's expected return.

Macroeconomic Factor Model for Harry Company Stock

Variable	Actual Value (%)	Expected Value (%)	Stock's Factor Sensitivity
Change in interest rate	2.0	0.0	–1.5
Growth in GDP	1.0	4.0	2.0

3 Assume that the following one-factor model describes the expected return for portfolios:

$$E(R_p) = 0.10 + 0.12\beta_{p,1}$$

Also assume that all investors agree on the expected returns and factor sensitivity of the three highly diversified Portfolios A, B, and C given in the following table:

Portfolio	Expected Return	Factor Sensitivity
A	0.20	0.80
B	0.15	1.00
C	0.24	1.20

Assuming the one-factor model is correct and based on the data provided for Portfolios A, B, and C, determine if an arbitrage opportunity exists and explain how it might be exploited.

4 Which type of factor model is most directly applicable to an analysis of the style orientation (for example, growth vs. value) of an active equity investment manager? Justify your answer.

5 Suppose an active equity manager has earned an active return of 110 basis points, of which 80 basis points is the result of security selection ability. Explain the likely source of the remaining 30 basis points of active return.

6 Address the following questions about the information ratio.

A What is the information ratio of an index fund that effectively meets its investment objective?

B What are the two types of risk an active investment manager can assume in seeking to increase his information ratio?

7 A wealthy investor has no other source of income beyond her investments and that income is expected to reliably meet all her needs. Her investment advisor recommends that she tilt her portfolio to cyclical stocks and high-yield bonds. Explain the advisor's advice in terms of comparative advantage in bearing risk.

The following information relates to Questions 8–13

Carlos Altuve is a manager-of-managers at an investment company that uses quantitative models extensively. Altuve seeks to construct a multi-manager portfolio using some of the funds managed by portfolio managers within the firm. Maya Zapata is assisting him.

Altuve uses arbitrage pricing theory (APT) as a basis for evaluating strategies and managing risks. From his earlier analysis, Zapata knows that Funds A and B in Exhibit 1 are well diversified. He has not previously worked with Fund C and is puzzled by the data because it is inconsistent with APT. He asks Zapata gather additional information on Fund C's holdings and to determine if an arbitrage opportunity exists among these three investment alternatives. Her analysis, using the data in Exhibit 1, confirms that an arbitrage opportunity does exist.

Exhibit 1 Expected Returns and Factor Sensitivities (One-Factor Model)

Fund	Expected Return	Factor Sensitivity
A	0.02	0.5
B	0.04	1.5
C	0.03	0.9

Using a two-factor model, Zapata now estimates the three funds' sensitivity to inflation and GDP growth. That information is presented in Exhibit 2. Zapata assumes a zero value for the error terms when working with the selected two-factor model.

Exhibit 2 Expected Returns and Factor Sensitivities (Two-Factor Model)

Fund	Expected Return	Factor Sensitivity	
		Inflation	GDP Growth
A	0.02	0.5	1.0
B	0.04	1.6	0.0
C	0.03	1.0	1.1

Altuve asks Zapata to calculate the return for Portfolio AC, composed of a 60% allocation to Fund A and 40% allocation to Fund C, using the surprises in inflation and GDP growth in Exhibit 3.

Exhibit 3 Selected Data on Factors

Factor	Research Staff Forecast	Actual Value
Inflation	2.0%	2.2%
GDP Growth	1.5%	1.0%

Finally, Altuve asks Zapata about the return sensitivities of Portfolios A, B, and C given the information provided in Exhibit 3.

8 Which of the following is *not* a key assumption of APT, which is used by Altuve to evaluate strategies and manage risks?

A A factor model describes asset returns.

B Asset-specific risk can be eliminated through diversification.

C Arbitrage opportunities exist among well-diversified portfolios.

9 The arbitrage opportunity identified by Zapata can be exploited with:

A Strategy 1: Buy $50,000 Fund A and $50,000 Fund B; sell short $100,000 Fund C.

B Strategy 2: Buy $60,000 Fund A and $40,000 Fund B; sell short $100,000 Fund C.

C Strategy 3: Sell short $60,000 of Fund A and $40,000 of Fund B; buy $100,000 Fund

10 The two-factor model Zapata uses is a:

A statistical factor model.

B fundamental factor model.

C macroeconomic factor model.

11 Based on the data in Exhibits 2 and 3, the return for Portfolio AC, given the surprises in inflation and GDP growth, is *closest* to:

A 2.02%.

B 2.40%.

C 4.98%.

12 The surprise in which of the following had the greatest effect on fund returns?

A Inflation on Fund B

B GDP growth on Fund A

C GDP growth on Fund C

13 Based on the data in Exhibit 2, which fund is most sensitive to the combined surprises in inflation and GDP growth in Exhibit 3?

A Fund A

B Fund B

C Fund C

The following information relates to Questions 14–19

Hui Cheung, a portfolio manager, asks her assistant, Ronald Lam, to review the macroeconomic factor model currently in use and to consider a fundamental factor model as an alternative.

The current macroeconomic factor model has four factors:

$$R_i = a_i + b_{i1}F_{\text{GDP}} + b_{i2}F_{\text{CAP}} + b_{i3}F_{\text{CON}} + b_{i4}F_{\text{UNEM}} + \varepsilon_i,$$

Where F_{GDP}, F_{CAP}, F_{CON}, and F_{UNEM} represent unanticipated changes in four factors: gross domestic product, manufacturing capacity utilization, consumer spending, and the rate of unemployment, respectively. Lam assumes the error term is equal to zero when using this model.

Lam estimates the current model using historical monthly returns for three portfolios for the most recent five years. The inputs used in and estimates derived from the macroeconomic factor model are presented in Exhibit 1. The US Treasury bond rate of 2.5% is used as a proxy for the risk-free rate of interest.

Exhibit 1 Inputs for and Estimates from the Current Macroeconomic Model

	Factor Sensitivities and Intercept Coefficients				
Factor	**Portfolio 1**	**Portfolio 2**	**Portfolio 3**	**Benchmark**	**Factor Surprise (%)**
Intercept (%)	2.58	3.20	4.33		
F_{GDP}	0.75	1.00	0.24	0.50	0.8
F_{CAP}	–0.23	0.00	–1.45	–1.00	0.5
F_{CON}	1.23	0.00	0.50	1.10	2.5
F_{UNEM}	–0.14	0.00	–0.05	–0.10	1.0
	Annual Returns, Most Recent Year				
Return (%)	6.00	4.00	5.00	4.50	

Lam uses the macroeconomic model to calculate the tracking error and the mean active return for each portfolio. He presents these statistics in Exhibit 2.

Exhibit 2 Macroeconomic Factor Model Tracking Error and Mean Active Return

Portfolio	Tracking Error	Mean Active Return
Portfolio 1	1.50%	1.50%
Portfolio 2	1.30%	–0.50%
Portfolio 3	1.00%	0.50%

Lam considers a fundamental factor model with four factors:

$$R_i = a_j + b_{j1}F_{\text{LIQ}} + b_{j2}F_{\text{LEV}} + b_{j3}F_{\text{EGR}} + b_{j4}F_{\text{VAR}} + \varepsilon_j,$$

where F_{LIQ}, F_{LEV}, F_{EGR}, and F_{VAR} represent liquidity, financial leverage, earnings growth, and the variability of revenues, respectively.

Lam and Cheung discuss similarities and differences between macroeconomic factor models and fundamental factor models, and Lam offers a comparison of those models to statistical factor models. Lam makes the following statements.

Statement 1 The factors in fundamental factor models are based on attributes of stocks or companies, whereas the factors in macroeconomic factor models are based on surprises in economic variables.

Statement 2 The factor sensitivities are generally determined first in fundamental factor models, whereas the factor sensitivities are estimated last in macroeconomic factor models.

Lam also tells Cheung:

> An advantage of statistical factor models is that they make minimal assumptions, and therefore, statistical factor model estimation lends itself to easier interpretation than macroeconomic and fundamental factor models.

Lam tells Cheung that multifactor models can be useful in active portfolio management, but not in passive management. Cheung disagrees; she tells Lam that multifactor models can be useful in both active and passive management.

14 Based on the information in Exhibit 1, the expected return for Portfolio 1 is *closest* to:

A 2.58%.

B 3.42%.

C 6.00%.

15 Based on Exhibit 1, the active risk for Portfolio 2 is explained by surprises in:

A GDP.

B consumer spending.

C all four model factors.

16 Based on Exhibit 2, which portfolio has the best information ratio?

A Portfolio 1

B Portfolio 2

C Portfolio 3

17 Which of Lam's statements regarding macroeconomic factor models and fundamental factor models is correct?

A Only Statement 1

B Only Statement 2

C Both Statements 1 and 2

18 Is Lam's comment regarding statistical factor models correct?

A Yes

B No, because he is incorrect with respect to interpretation of the models' results

C No, because he is incorrect with respect to the models' assumptions

19 Whose statement regarding the use of multifactor models in active and passive portfolio management is correct?

A Lam only

B Cheung only

C Both Lam and Cheung

SOLUTIONS

1 APT and the CAPM are both models that describe what the expected return on a risky asset should be in equilibrium given its risk. The CAPM is based on a set of assumptions including the assumption that investors' portfolio decisions can be made considering just returns' means, variances, and correlations. The APT makes three assumptions:

1 A factor model describes asset returns.

2 There are many assets, so investors can form well-diversified portfolios that eliminate asset-specific risk.

3 No arbitrage opportunities exist among well-diversified portfolios.

2 In a macroeconomic factor model, the surprise in a factor equals actual value minus expected value. For the interest rate factor, the surprise was 2 percent; for the GDP factor, the surprise was –3 percent. The intercept represents expected return in this type of model. The portion of the stock's return not explained by the factor model is the model's error term.

5% = Expected return – 1.5(Interest rate surprise) + 2(GDP surprise) + Error term
= Expected return – 1.5(2%) + 2(–3%) + 3%
= Expected return – 6%

Rearranging terms, the expected return for Harry Company stock equals 5% + 6% = 11%.

3 According to the one-factor model for expected returns, the portfolio should have these expected returns if they are correctly priced in terms of their risk:

Portfolio A $E(R_A) = 0.10 + 0.12\beta_{A,1} = 0.10 + (0.12)(0.80) = 0.10 + 0.10 = 0.20$

Portfolio B $E(R_B) = 0.10 + 0.12\beta_{B,1} = 0.10 + (0.12)(1.00) = 0.10 + 0.12 = 0.22$

Portfolio C $E(R_C) = 0.10 + 0.12\beta_{C,1} = 0.10 + (0.12)(1.20) = 0.10 + 0.14 = 0.24$

In the table below, the column for expected return shows that Portfolios A and C are correctly priced but Portfolio B offers too little expected return for its risk, 0.15 or 15%. By shorting Portfolio B (selling an overvalued portfolio) and using the proceeds to buy a portfolio 50% invested in A and 50% invested in C with a sensitivity of 1 that matches the sensitivity of B, for each monetary unit shorted (say each euro), an arbitrage profit of €0.22 – €0.15 = €0.07 is earned.

Portfolio	Expected Return	Factor Sensitivity
A	0.20	0.80
B	0.15	1.00
C	0.24	1.20
0.5A + 0.5C	0.22	1.00

4 A fundamental factor model. Such models typically include many factors related to the company (e.g., earnings) and to valuation that are commonly used indicators of a growth orientation. A macroeconomic factor model may provide relevant information as well, but typically indirectly and in less detail.

5 This remainder of 30 basis points would be attributable to the return from factor tilts. A portfolio manager's active return is the sum of two components, factor tilts and security selection. Factor tilt is the product of the portfolio manager's higher or lower factor sensitivities relative to the benchmark's factor sensitivities and the factor returns. Security selection reflects the manager's ability to overweight securities that outperform or underweight securities that underperform.

6 **A** An index fund that effectively meets its investment objective is expected to have an information ratio of zero, because its active return should be zero.

B The active manager may assume active factor risk and active specific risk (security selection risk) in seeking a higher information ratio.

7 This wealthy investor has a comparative advantage in bearing business cycle risk compared with the average investor who depends on income from employment. Because the average investor is sensitive to the business cycle and in particular the risk of recession, we would expect there to be a risk premium to hold recession-sensitive securities. Cyclical stocks and high-yield bonds are both very sensitive to the risk of recessions. Because the welfare of the wealthy investor is not affected by recessions, she can tilt her portfolio to include cyclical stocks and high yield bonds to attempt to capture the associated risk premiums.

8 C is correct. Arbitrage pricing theory (APT) is a framework that explains the expected return of a portfolio in equilibrium as a linear function of the risk of the portfolio with respect to a set of factors capturing systematic risk. A key assumption of APT is that, in equilibrium, there are no arbitrage opportunities.

9 C is correct. The expected return and factor sensitivities of a portfolio with a 60% weight in Fund A and a 40% weight in Fund B are calculated as weighted averages of the expected returns and factor sensitivities of Funds A and B:

$$\begin{aligned}\text{Expected return of Portfolio 60/40} &= (0.60)(0.02) + (0.40)(0.04)\\ &= 0.028, \text{ or } 2.8\%\\ \text{Factor sensitivity of Portfolio 60/40} &= (0.60)(0.5) + (0.40)(1.5)\\ &= 0.9\end{aligned}$$

Fund	Expected Return	Factor Sensitivity
A	0.02	0.5
B	0.04	1.5
C	0.03	0.9
Portfolio 60/40		
60%A + 40%B	0.028	0.900
Portfolio 50/50		
50%A + 50%B	0.030	1.000

The factor sensitivity of Portfolio 60/40 is identical to that of Fund C; therefore, this strategy results in no factor risk relative to Portfolio C. However, Fund C's expected return of 3.0% is higher than Portfolio 60/40's expected return of 2.8%. This difference supports Strategy 3: buying Fund C and selling short Portfolio 60/40 to exploit the arbitrage opportunity.

10 C is correct. In a macroeconomic factor model, the factors are surprises in macroeconomic variables, such as inflation risk and GDP growth, that significantly explain returns.

11 A is correct. The macroeconomic two-factor model takes the following form:

$$R_i = a_i + b_{i1}F_{\text{INF}} + b_{i2}F_{\text{GDP}} + \varepsilon_i,$$

where F_{INF} and F_{GDP} represent surprises in inflation and surprises in GDP growth, respectively, and a_i represents the expected return to asset i. Using this model and the data in Exhibit 2, the returns for Fund A and Fund C are represented by the following:

$$R_A = 0.02 + 0.5F_{\text{INF}} + 1.0F_{\text{GDP}} + \varepsilon_A$$

$$R_C = 0.03 + 1.0F_{\text{INF}} + 1.1F_{\text{GDP}} + \varepsilon_C$$

Surprise in a macroeconomic model is defined as actual factor minus predicted factor. The surprise in inflation is 0.2% (= 2.2% – 2.0%). The surprise in GDP growth is –0.5% (= 1.0% – 1.5%). The return for Portfolio AC, composed of a 60% allocation to Fund A and 40% allocation to Fund C, is calculated as the following:

$$\begin{aligned} R_{AC} &= (0.6)(0.02) + (0.4)(0.03) + [(0.6)(0.5) + (0.4)(1.0)](0.002) + [(0.6)(1.0) \\ &\quad + (0.4)(1.1)](-0.005) + 0.6(0) + 0.4(0) \\ &= 2.02\% \end{aligned}$$

12 C is correct. Surprise in a macroeconomic model is defined as actual factor minus predicted factor. For inflation, the surprise factor is 2.2% – 2.0% = 0.2%; for GDP growth, the surprise factor is 1.0% – 1.5% = –0.5%. The effect on returns is the product of the surprise and the factor sensitivity.

	Change in Portfolio Return due to Surprise in	
Fund	**Inflation**	**GDP Growth**
A	0.5 × 0.2% = 0.10%	1.0 × –0.5% = –0.50%
B	1.6 × 0.2% = 0.32%	0.0 × –0.5% = 0.00%
C	1.0 × 0.2% = 0.20%	1.1 × –0.5% = –0.55%

The effect of the GDP growth surprise on Fund C was the largest single-factor effect on Fund returns (–0.55%).

13 A is correct. The effect of the surprises in inflation and GDP growth on the returns of the three funds is calculated as the following.

	Change in Portfolio Return Because of Surprise in	
Fund	**Inflation**	**GDP Growth**
A	0.5 × 0.2% = 0.10%	1.0 × –0.5% = –0.50%
B	1.6 × 0.2% = 0.32%	0.0 × –0.5% = 0.00%
C	1.0 × 0.2% = 0.20%	1.1 × –0.5% = –0.55%

The combined effects for the three funds are the following.

Fund A: 0.10% + (–0.50%) = –0.40%

Fund B: 0.32% + (0.00%) = 0.32%

Fund C: 0.20% + (–0.55%) = –0.35%

Therefore, Fund A is the most sensitive to the surprises in inflation and GDP growth in Exhibit 3.

14 A is correct. When using a macroeconomic factor, the expected return is the intercept (when all model factors take on a value of zero). The intercept coefficient for Portfolio 1 in Exhibit 1 is 2.58.

15 C is correct. Active risk, also referred to as tracking risk or tracking error, is the sample standard deviation of the time series of active returns, where the active returns consist of the differences between the portfolio return and the benchmark return. Whereas GDP is the only portfolio non-zero sensitivity for Portfolio 2, the contribution to the portfolio's active return is the sum of the differences between the portfolio's and the benchmark's sensitivities multiplied by the factor return. Because all four of the factor sensitivities of Portfolio 2 are different from the factor sensitivities of the benchmark, all four factors contribute to the portfolio's active return and, therefore, to its active risk.

16 A is correct. Portfolio 1 has the highest information ratio, 1.0, and thus has the best mean active return per unit of active risk:

$$\begin{aligned} \text{IR} &= \frac{\bar{R}_P - \bar{R}_B}{s\left(R_P - R_B\right)} \\ &= \frac{1.50\%}{1.50\%} \\ &= 1.00 \end{aligned}$$

This information ratio exceeds that of Portfolio 2 (–0.38) or Portfolio 3 (0.50).

17 C is correct. In a macroeconomic factor model, the factors are surprises in macroeconomic variables that significantly explain returns. Factor sensitivities are generally specified first in fundamental factor models, whereas factor sensitivities are estimated last in macroeconomic factor models.

18 B is correct. An advantage of statistical factor models is that they make minimal assumptions. However, the interpretation of statistical factors is generally more difficult than the interpretation of macroeconomic and fundamental factor models.

19 B is correct. Analysts can use multifactor models in passively managed portfolios to replicate an index fund's factor exposures.

PRACTICE PROBLEMS

The following information relates to Questions 1–5

Randy Gorver, chief risk officer at Eastern Regional Bank, and John Abell, assistant risk officer, are currently conducting a risk assessment of several of the bank's independent investment functions. These reviews include the bank's fixed-income investment portfolio and an equity fund managed by the bank's trust department. Gorver and Abell are also assessing Eastern Regional's overall risk exposure.

Eastern Regional Bank Fixed-Income Investment Portfolio

The bank's proprietary fixed-income portfolio is structured as a barbell portfolio: About half of the portfolio is invested in zero-coupon Treasuries with maturities in the 3- to 5-year range (Portfolio P_1), and the remainder is invested in zero-coupon Treasuries with maturities in the 10- to 15-year range (Portfolio P_2). Georges Montes, the portfolio manager, has discretion to allocate between 40% and 60% of the assets to each maturity "bucket." He must remain fully invested at all times. Exhibit 1 shows details of this portfolio.

Exhibit 1 US Treasury Barbell Portfolio

	Maturity	
	P_1	P_2
	3–5 Years	10–15 Years
Average duration	3.30	11.07
Average yield to maturity	1.45%	2.23%
Market value	$50.3 million	$58.7 million

Trust Department's Equity Fund

a **Use of Options:** The trust department of Eastern Regional Bank manages an equity fund called the Index Plus Fund, with $325 million in assets. This fund's objective is to track the S&P 500 Index price return while producing an income return 1.5 times that of the S&P 500. The bank's chief investment officer (CIO) uses put and call options on S&P 500 stock index futures to adjust the risk exposure of certain client accounts that have an investment in this fund. The portfolio of a 60-year-old widow with a below-average risk tolerance has an investment in this fund, and the CIO has asked his assistant, Janet Ferrell, to propose an options strategy to bring the portfolio's delta to 0.90.

b **Value at Risk**: The Index Plus Fund has a one-day 95% value at risk (VaR) of $6.5 million. Gorver asks Abell to write a brief summary of the portfolio VaR for the report he is preparing on the fund's risk position.

Combined Bank Risk Exposures

The bank has adopted a new risk policy, which requires forward-looking risk assessments in addition to the measures that look at historical risk characteristics. Management has also become very focused on tail risk since the subprime crisis and is evaluating the bank's capital allocation to certain higher-risk lines of business. Gorver must determine what additional risk metrics to include in his risk reporting to address the new policy. He asks Abell to draft a section of the risk report that will address the risk measures' adequacy for capital allocation decisions.

1 If Montes is expecting a 50 bp increase in yields at all points along the yield curve, which of the following trades is he *most likely* to execute to minimize his risk?

A Sell $35 million of P_2 and reinvest the proceeds in three-year bonds

B Sell $15 million of P_2 and reinvest the proceeds in three-year bonds.

C Reduce the duration of P_2 to 10 years and reduce the duration of P_1 to 3 years

2 Which of the following options strategies is Ferrell *most likely* to recommend for the client's portfolio?

A Long calls

B Short calls

C Short puts

3 Which of the following statements regarding the VaR of the Index Plus Fund is correct?

A The expected maximum loss for the portfolio is $6.5 million.

B Five percent of the time, the portfolio can be expected to experience a loss of at least $6.5 million.

C Ninety-five percent of the time, the portfolio can be expected to experience a one-day loss of no more than $6.5 million.

4 To comply with the new bank policy on risk assessment, which of the following is the *best* set of risk measures to add to the chief risk officer's risk reporting?

A Conditional VaR, stress test, and scenario analysis

B Monte Carlo VaR, incremental VaR, and stress test

C Parametric VaR, marginal VaR, and scenario analysis

5 Which of the following statements should *not* be included in Abell's report to management regarding the use of risk measures in capital allocation decisions?

A VaR measures capture the increased liquidity risk during stress periods.

B Stress tests and scenario analysis can be used to evaluate the effect of outlier events on each line of business.

C VaR approaches that can accommodate a non-normal distribution are critical to understand relative risk across lines of business.

The following information relates to Questions 6–11

Hiram Life (Hiram), a large multinational insurer located in Canada, has received permission to increase its ownership in an India-based life insurance company, LICIA, from 26% to 49%. Before completing this transaction, Hiram wants to complete a risk assessment of LICIA's investment portfolio. Judith Hamilton, Hiram's chief financial officer, has been asked to brief the management committee on investment risk in its India-based insurance operations.

LICIA's portfolio, which has a market value of CAD 260 million, is currently structured as shown in Exhibit 1. Despite its more than 1,000 individual holdings, the portfolio is invested predominantly in India. The Indian government bond market is highly liquid, but the country's mortgage and infrastructure loan markets, as well as the corporate bond market, are relatively illiquid. Individual mortgage and corporate bond positions are large relative to the normal trading volumes in these securities. Given the elevated current and fiscal account deficits, Indian investments are also subject to above-average economic risk.

Hamilton begins with a summary of the India-based portfolio. Exhibit 1 presents the current portfolio composition and the risk and return assumptions used to estimate value at risk (VaR).

Exhibit 1 Selected Assumptions for LICIA's Investment Portfolio

	Allocation	Average Daily Return	Daily Standard Deviation
India government securities	50%	0.015%	0.206%
India mortgage/infrastructure loans	25%	0.045%	0.710%
India corporate bonds	15%	0.025%	0.324%
India equity	10%	0.035%	0.996%

Infrastructure is a rapidly growing asset class with limited return history; the first infrastructure loans were issued just 10 years ago.

Hamilton's report to the management committee must outline her assumptions and provide support for the methods she used in her risk assessment. If needed, she will also make recommendations for rebalancing the portfolio to ensure its risk profile is aligned with that of Hiram.

Hamilton develops the assumptions shown in Exhibit 2, which will be used for estimating the portfolio VaR.

Exhibit 2 VaR Input Assumptions for Proposed CAD 260 Million Portfolio

Method	Average Return Assumption	Standard Deviation Assumption
Monte Carlo simulation	0.026%	0.501%
Parametric approach	0.026%	0.501%
Historical simulation	0.023%	0.490%

Hamilton elects to apply a one-day, 5% VaR limit of CAD 2 million in her risk assessment of LICIA's portfolio. This limit is consistent with the risk tolerance the committee has specified for the Hiram portfolio.

The markets' volatility during the last 12 months has been significantly higher than the historical norm, with increased frequency of large daily losses, and Hamilton expects the next 12 months to be equally volatile.

She estimates the one-day 5% portfolio VaR for LICIA's portfolio using three different approaches:

Exhibit 3 VaR Results over a One-Day Period for Proposed Portfolio

Method	5% VaR
Monte Carlo simulation	CAD 2,095,565
Parametric approach	CAD 2,083,610
Historic simulation	CAD 1,938,874

The committee is likely to have questions in a number of key areas—the limitations of the VaR report, potential losses in an extreme adverse event, and the reliability of the VaR numbers if the market continues to exhibit higher-than-normal volatility. Hamilton wants to be certain that she has thoroughly evaluated the risks inherent in the LICIA portfolio and compares them with the risks in Hiram's present portfolio.

Hamilton believes the possibility of a ratings downgrade on Indian sovereign debt is high and not yet fully reflected in securities prices. If the rating is lowered, many of the portfolio's holdings will no longer meet Hiram's minimum ratings requirement. A downgrade's effect is unlikely to be limited to the government bond portfolio. All asset classes can be expected to be affected to some degree. Hamilton plans to include a scenario analysis that reflects this possibility to ensure that management has the broadest possible view of the risk exposures in the India portfolio.

6 Given Hamilton's expectations, which of the following models is *most appropriate* to use in estimating portfolio VaR?

A Parametric method

B Historical simulation method

C Monte Carlo simulation method

7 Which risk measure is Hamilton *most likely* to present when addressing the committee's concerns regarding potential losses in extreme stress events?

A Relative VaR

B Incremental VaR

C Conditional VaR

8 The scenario analysis that Hamilton prepares for the committee is *most likely* a:

A stress test.

B historical scenario.

C hypothetical scenario.

9 The scenario analysis that Hamilton prepares for the committee is a valuable tool to supplement VaR *because* it:

A incorporates historical data to evaluate the risk in the tail of the VaR distribution.

B enables Hamilton to isolate the risk stemming from a single risk factor—the ratings downgrade.

C allows the committee to assess the effect of low liquidity in the event of a ratings downgrade.

10 Using the data in Exhibit 2, the portfolio's annual 1% parametric VaR is *closest* to:

A CAD 17 million.

B CAD 31 million.

C CAD 48 million.

11 What additional risk measures would be most appropriate to add to Hamilton's risk assessment?

A Delta

B Duration

C Tracking error

The following information relates to Questions 12–19

Tina Ming is a senior portfolio manager at Flusk Pension Fund (Flusk). Flusk's portfolio is composed of fixed-income instruments structured to match Flusk's liabilities. Ming works with Shrikant McKee, Flusk's risk analyst.

Ming and McKee discuss the latest risk report. McKee calculated value at risk (VaR) for the entire portfolio using the historical method and assuming a lookback period of five years and 250 trading days per year. McKee presents VaR measures in Exhibit 1.

Exhibit 1 Flusk Portfolio VaR (in $ millions)

Confidence Interval	Daily VaR	Monthly VaR
95%	1.10	5.37

After reading McKee's report, Ming asks why the number of daily VaR breaches over the last year is zero even though the portfolio has accumulated a substantial loss.

Next Ming requests that McKee perform the following two risk analyses on Flusk's portfolio:

Analysis 1 Use scenario analysis to evaluate the impact on risk and return of a repeat of the last financial crisis.

Analysis 2 Estimate over one year, with a 95% level of confidence, how much Flusk's assets could underperform its liabilities.

Ming recommends purchasing newly issued emerging market corporate bonds that have embedded options. Prior to buying the bonds, Ming wants McKee to estimate the effect of the purchase on Flusk's VaR. McKee suggests running a stress test using a historical period specific to emerging markets that encompassed an extreme change in credit spreads.

At the conclusion of their conversation, Ming asks the following question about risk management tools: "What are the advantages of VaR compared with other risk measures?"

12 Based on Exhibit 1, Flusk's portfolio is expected to experience:

A a minimum daily loss of $1.10 million over the next year.

B a loss over one month equal to or exceeding $5.37 million 5% of the time.

C an average daily loss of $1.10 million 5% of the time during the next 250 trading days.

13 The number of Flusk's VaR breaches *most likely* resulted from:

A using a standard normal distribution in the VaR model.

B using a 95% confidence interval instead of a 99% confidence interval.

C lower market volatility during the last year compared with the lookback period.

14 To perform Analysis 1, McKee should use historical bond:

A prices.

B yields.

C durations.

15 The limitation of the approach requested for Analysis 1 is that it:

A omits asset correlations.

B precludes incorporating portfolio manager actions.

C assumes no deviation from historical market events.

16 The estimate requested in Analysis 2 is *best* described as:

A liquidity gap.

B surplus at risk.

C maximum drawdown.

17 Which measure should McKee use to estimate the effect on Flusk's VaR from Ming's portfolio recommendation?

A Relative VaR

B Incremental VaR

C Conditional VaR

18 When measuring the portfolio impact of the stress test suggested by McKee, which of the following is *most likely* to produce an accurate result?

A Marginal VaR

B Full revaluation of securities

C The use of sensitivity risk measures

19 The risk management tool referenced in Ming's question:

A is widely accepted by regulators.

B takes into account asset liquidity.

C usually incorporates right-tail events.

The following information relates to questions 20–26

Carol Kynnersley is the chief risk officer at Investment Management Advisers (IMA). Kynnersley meets with IMA's portfolio management team and investment advisers to discuss the methods used to measure and manage market risk and how risk metrics are presented in client reports.

The three most popular investment funds offered by IMA are the Equity Opportunities, the Diversified Fixed Income, and the Alpha Core Equity. The Equity Opportunities Fund is composed of two exchange-traded funds: a broadly diversified large-cap equity product and one devoted to energy stocks. Kynnersley makes the following statements regarding the risk management policies established for the Equity Opportunities portfolio:

Statement 1 IMA's preferred approach to model value at risk (VaR) is to estimate expected returns, volatilities, and correlations under the assumption of a normal distribution.

Statement 2 In last year's annual client performance report, IMA stated that a hypothetical $6 million Equity Opportunities Fund account had a daily 5% VaR of approximately 1.5% of portfolio value.

Kynnersley informs the investment advisers that the risk management department recently updated the model for estimating the Equity Opportunities Fund VaR based on the information presented in Exhibit 1.

Exhibit 1 Equity Opportunities Fund—VaR Model Input Assumptions

	Large-Cap ETF	Energy ETF	Total Portfolio
Portfolio weight	65.0%	35.0%	100.0%
Expected annual return	12.0%	18.0%	14.1%
Standard deviation	20.0%	40.0%	26.3%

Correlation between ETFs: 0.90
Number of trading days/year: 250

For clients interested in fixed-income products, IMA offers the Diversified Fixed-Income Fund. Kynnersley explains that the portfolio's bonds are all subject to interest rate risk. To demonstrate how fixed-income exposure measures can be used to identify and manage interest rate risk, Kynnersley distributes two exhibits featuring three hypothetical Treasury coupon bonds (Exhibit 2) under three interest rate scenarios (Exhibit 3).

Exhibit 2 Fixed-Income Risk Measure

Hypothetical Bond	Duration
Bond 1	1.3
Bond 2	3.7
Bond 3	10.2

Exhibit 3: Interest Rate Scenarios

Scenario	Interest Rate Environment
Scenario 1	Rates increase 25 bps
Scenario 2	Rates increase 10 bps
Scenario 3	Rates decrease 20 bps

One of the investment advisers comments that a client recently asked about the performance of the Diversified Fixed-Income Fund relative to its benchmark, a broad fixed-income index. Kynnersley informs the adviser as follows:

Statement 3 The Diversified Fixed-Income Fund manager monitors the historical deviation between portfolio returns and benchmark returns. The fund prospectus stipulates a target deviation from the benchmark of no more than 5 bps.

Kynnersley concludes the meeting by reviewing the constraints IMA imposes on securities included in the Alpha Core Equity Fund. The compliance department conducts daily oversight using numerous risk screens and, when indicated, notifies portfolio managers to make adjustments. Kynnersley makes the following statement:

Statement 4 It is important that all clients investing in the fund be made aware of IMA's compliance measures. The Alpha Core Equity Fund restricts the exposure of individual securities to 1.75% of the total portfolio.

20 Based on Statement 1, IMA's VaR estimation approach is *best* described as the:

A parametric method.

B historical simulation method.

C Monte Carlo simulation method.

21 In Statement 2, Kynnersley implies that the portfolio:

A is at risk of losing $4,500 each trading day.

B value is expected to decline by $90,000 or more once in 20 trading days.

C has a 5% chance of falling in value by a maximum of $90,000 on a single trading day.

22 Based *only* on Statement 2, the risk measurement approach:

A ignores right-tail events in the return distribution.

B is similar to the Sharpe ratio because it is backward looking.

C provides a relatively accurate risk estimate in both trending and volatile regimes.

23 Based on Exhibit 1, the daily 5% VaR estimate is *closest* to:

A 1.61%.

B 2.42%.

C 2.69%.

24 Based *only* on Exhibits 2 and 3, it is *most likely* that under:

A Scenario 1, Bond 2 outperforms Bond 1.

B Scenario 2, Bond 1 underperforms Bond 3.

C Scenario 3, Bond 3 is the best performing security.

25 The risk measure referred to in Statement 3 is:

A active share.

B beta sensitivity

C *ex post* tracking error.

26 In Statement 4, Kynnersley describes a constraint associated with a:

A risk budget.

B position limit.

C stop-loss limit.

SOLUTIONS

1 B is correct. Duration is a measure of interest rate risk. To reduce risk in anticipation of an increase in interest rates, Montes would seek to shorten the portfolio's duration. He is limited, however, in the amount he can shift from P_2 to P_1. Selling $15 million of P_2 reduces that portfolio to the lower end of the permitted 40% to 60% range. By reinvesting the proceeds at the shortest maturities allowed, Montes substantially reduces the portfolio duration.

2 B is correct. An index-tracking portfolio without options has a delta of 1. To achieve a delta of 0.9, the delta of the options position must be negative. Of the three choices, only short calls have a negative delta. Long call options have deltas ranging from 0 to 1. Short calls, therefore, have deltas ranging from 0 to −1. The short call position lowers the portfolio's overall delta as desired.

3 B is correct. VaR measures the frequency of losses of a given minimum magnitude. Here the VaR indicates that on 5% of trading days, the portfolio will experience a loss of at least $6.5 million. (Although C may appear to say the same thing as B, it actually implies that the portfolio will experience a loss on 95% of trading days.) The correct interpretation is that returns will be equal to or greater than −$6.5 million on 95% of trading days; those returns include gains as well as losses.

4 A is correct. The bank policy requires the addition of forward-looking risk assessments, and management is focused on tail risk. Conditional VaR measures tail risk, and stress tests and scenario analysis subject current portfolio holdings to historical or hypothetical stress events.

5 A is correct. VaR measures do *not* capture liquidity risk. "If some assets in a portfolio are relatively illiquid, VaR could be understated, even under normal market conditions. Additionally, liquidity squeezes are frequently associated with tail events and major market downturns, thereby exacerbating the risk."

6 C is correct. The Monte Carlo simulation method can accommodate virtually any distribution, an important factor given the increased frequency of large daily losses. This method can also more easily accommodate the large number of portfolio holdings. The Monte Carlo method allows the user to develop her own forward-looking assumptions about the portfolio's risk and return characteristics, unlike the historical simulation method, which uses the current portfolio and re-prices it using the actual historical changes in the key factors experienced during the look-back period. Given the limited return history for infrastructure investments and Hamilton's expectations for higher-than-normal volatility, the historical simulation method would be a suboptimal choice.

7 C is correct. Conditional VaR is a measure of tail risk that provides an estimate of the average loss that would be incurred if the VaR cutoff is exceeded.

8 C is correct. A hypothetical scenario analysis allows the risk manager to estimate the likely effect of the scenario on a range of portfolio risk factors. A sovereign ratings downgrade would affect Hiram's India equity and corporate bond exposures as well as the government bond exposure. In addition, the assumptions used in constructing the scenario analysis can specifically address the effect of a need to sell large position sizes under decreased liquidity conditions resulting from a ratings downgrade. VaR alone does not accurately reflect the risk of large position sizes, which may be difficult to trade.

9 C is correct. A hypothetical scenario analysis allows Hamilton to estimate the direct effect of a ratings downgrade on the portfolio's government bond holdings and the resulting need to sell a number of the portfolio's holdings because they no longer meet the ratings guidelines. VaR alone does not accurately reflect the risk of large position sizes, which may be difficult to trade. The hypothetical scenario analysis will also highlight the effect of increased economic turmoil on all of the portfolio's exposures, not only the government bond exposures.

10 B is correct. The VaR is derived as follows:

$$\text{VaR} = [(E(Rp) - 2.33\sigma_p)(-1)](\text{Portfolio value})$$

where

$E(R_p)$ = Annualized daily return = $(0.00026 \times 250) = 0.065$
250 = Number of trading days annually
2.33 = Number of standard deviations to attain 1% VaR
σ_p = Annualized standard deviation = $\left(0.0051 \times \sqrt{250}\right) = 0.079215$

Portfolio value = CAD 260,000,000

$$\text{VaR} = -(0.065 - 0.184571) \times \text{CAD } 260{,}000{,}000$$
$$= \text{CAD}31{,}088{,}460$$

11 B is correct. Given the large fixed-income exposure in the LICIA portfolio, examining the portfolio duration more closely would be prudent. Duration is the primary sensitivity exposure measure for fixed-income investments.

12 B is correct. VaR is the minimum loss that would be expected a certain percentage of the time over a specified period of time given the assumed market conditions. A 5% VaR is often expressed as its complement—a 95% level of confidence. Therefore, the monthly VaR in Exhibit 1 indicates that $5.37 million is the minimum loss that would be expected to occur over one month 5% of the time. Alternatively, 95% of the time, a loss of more than $5.37 million would not be expected.

13 C is correct. Flusk experienced zero daily VaR breaches over the last year yet incurred a substantial loss. A limitation of VaR is its vulnerability to different volatility regimes. A portfolio might remain under its VaR limit every day but lose an amount approaching this limit each day. If market volatility during the last year is lower than in the lookback period, the portfolio could accumulate a substantial loss without technically breaching the VaR constraint.

A is incorrect because VaR was calculated using historical simulation, so the distribution used was based on actual historical changes in the key risk factors experienced during the lookback period. Thus, the distribution is not characterized using estimates of the mean return, the standard deviation, or the correlations among the risk factors in the portfolio. In contrast, the parametric method of estimating VaR generally assumes that the distribution of returns for the risk factors is normal.

B is incorrect because a specification with a higher confidence level will produce a higher VaR. If a 99% confidence interval was used to calculate historical VaR, the VaR would be larger (larger expected minimum loss). During the last year, none of Flusk's losses were substantial enough to breach the 5% VaR number (95% confidence interval); therefore, if McKee used a 1% VaR (99% confidence interval), the number of VaR breaches would not change.

14 B is correct. In order to simulate the impact of the latest financial crisis on the current bond portfolio holdings, McKee's valuation model for bonds should use the historical yields of bonds with similar maturity. Historical yields drive the pricing of bonds more than the price history or the current duration. Historical prices for the fixed-income positions currently held in the portfolio may not exist, and even when historical prices do exist, they may not be relevant to the current characteristics (e.g., maturity) of the instrument. Even if the same bonds existed at the time of the latest financial crisis, their durations would change because of the passage of time.

A is incorrect because using a bond's past price history would mischaracterize the risk of the current portfolio holdings. For this reason, the historical yields are more important in explaining the risks. Historical prices for the fixed-income positions currently held in the portfolio may not exist, and even when historical prices do exist, they may not be relevant to the current characteristics (e.g., maturity) of the instrument.

C is incorrect because historical bond durations would not capture the current characteristics of the bonds in the portfolio. Duration is a sensitivity measure and is the weighted-average time to maturity of a bond. Even if the same bonds existed at the time of the latest financial crisis, their remaining time to maturity and durations would change because of the passage of time.

15 C is correct. Ming suggested in Analysis 1 to use a historical scenario that measures the hypothetical portfolio return that would result from a repeat of a particular period of financial market history. Historical scenarios are complementary to VaR but are not going to happen in exactly the same way again, and they require additional measures to overcome the shortcomings of the VaR.

16 B is correct. Analysis 2 describes surplus at risk. Surplus at risk is an application of VaR; it estimates how much the assets might underperform the liabilities with a given confidence level, usually over a year.

17 B is correct. Incremental VaR measures the change in a portfolio's VaR as a result of adding or removing a position from the portfolio or if a position size is changed relative to the remaining positions.

18 B is correct. McKee suggests running a stress test using a historical scenario specific to emerging markets that includes an extreme change in credit spreads. Stress tests, which apply extreme negative stress to a particular portfolio exposure, are closely related to scenario risk measures. A scenario risk measure estimates the portfolio return that would result from a hypothetical change in markets (hypothetical scenario) or a repeat of a historical event (historical scenario). When the historical simulation fully revalues securities under rate and price changes that occurred during the scenario period, the results should be highly accurate.

A is incorrect because marginal VaR measures the change in portfolio VaR given a very small change in a portfolio position (e.g., change in VaR for a $1 or 1% change in the position). Therefore, marginal VaR would not allow McKee to estimate how much the value of the option-embedded bonds would change under an extreme change in credit spreads.

C is incorrect because sensitivity risk measures use sensitivity exposure measures, such as first-order (delta, duration) and second-order (gamma, convexity) sensitivity, to assess the change in the value of a financial instrument. Although gamma and convexity can be used with delta and duration to estimate the impact of extreme market movements, they are not suited for scenario analysis related to option-embedded bonds.

19 A is correct. VaR has emerged as one of the most popular risk measures because global banking regulators require or encourage the use of it. VaR is also frequently found in annual reports of financial firms and can be used for comparisons.

20 A is correct. VaR is an estimate of the loss that is expected to be exceeded with a given level of probability over a specified time period. The parametric method typically assumes that the return distributions for the risk factors in the portfolio are normal. It then uses the expected return and standard deviation of return for each risk factor and correlations to estimate VaR.

21 B is correct. Value at risk is the minimum loss that would be expected a certain percentage of the time over a certain period of time. Statement 2 implies that there is a 5% chance the portfolio will fall in value by $90,000 (= $6,000,000 × 1.5%) or more in a single day. If VaR is measured on a daily basis and a typical month has 20–22 business days, then 5% of the days equates to about 1 day per month or once in 20 trading days.

22 A is correct. Statement 2 indicates that the Equity Opportunities Fund reported a daily VaR value. One of the limitations of VaR is that it focuses so heavily on left-tail events (the losses) that right-tail events (potential gains) are often ignored.

B is incorrect because VaR is viewed as forward looking in that it uses the current portfolio holdings and measures its potential loss. The Sharpe ratio represents a backward-looking return-based measure and is used to assess the skill of the manager.

C is incorrect because VaR does not provide an accurate risk estimate in either trending or volatile regimes. A portfolio might remain under its VaR limit every day but lose an amount approaching this limit each day. Under such circumstances, the portfolio could accumulate substantial losses without technically breaching the VaR constraint. Also, during periods of low volatility, VaR will appear quite low, underestimating the losses that could occur when the environment returns to a normal level of volatility.

23 C is correct. Measuring VaR at a 5% threshold produces an estimated value at risk of 2.69%.

From Exhibit 1, the annual portfolio return is 14.1% and the standard deviation is 26.3%. Annual values need to be adjusted to get their daily counterparts. Assuming 250 trading days in a year, the expected annual return is adjusted by dividing by 250 and the standard deviation is adjusted by dividing by the square root of 250.

Thus, the daily expected return is 0.141/250 = 0.000564 and volatility is $0.263/\sqrt{250} = 0.016634$.

5% daily VaR = $E(R_p) - 1.65\sigma_p = 0.000564 - 1.65(0.016634) = -0.026882$. The portfolio is expected to experience a potential minimum loss in percentage terms of 2.69% on 5% of trading days.

24 C is correct. The change in value of a bond is inversely related to a change in yield. Given a bond priced at B with duration D and yield change of Δy, the rate of return or percentage price change for the bond is approximately given as follows: $\Delta B/B \approx -D\Delta y/(1 + y)$. Under Scenario 3, interest rates decrease by 20 bps. In an environment of decreasing interest rates, the bond with the highest duration will have the greatest positive return. Bond 3 has a duration of 10.2, which is greater than that of both Bond 1 (duration = 1.3) and Bond 2 (duration = 3.7).

25 C is correct. A traditional asset manager uses *ex post* tracking error when analyzing backward-looking returns. The Diversified Fixed-Income Fund prospectus stipulates a target benchmark deviation of no more than 5 bps. Tracking error is a measure of the degree to which the performance of a given investment deviates from its benchmark.

26 B is correct. Position limits are limits on the market value of any given investment; they are excellent controls on overconcentration. Position limits can be expressed in currency units or as a percentage of net assets. The Alpha Core Equity Fund restricts the exposure of individual securities to 1.75% of the total portfolio.

PRACTICE PROBLEMS

1 All else equal, which of the following would *most likely* explain the fall in price of a particular company's shares?

A The expected inflation rate falls.

B The company's future cash flows are expected to increase.

C The yield to maturity on real default-free investments rises.

2 The prices of one-period, real default-free government bonds are likely to be *most* sensitive to changes in:

A investors' inflation expectations.

B the expected volatility of economic growth.

C the covariance between investors' inter-temporal rates of substitution and the expected future prices of the bonds.

3 The covariance between a risk-averse investor's inter-temporal rate of substitution and the expected future price of a risky asset is typically:

A negative.

B zero.

C positive.

4 Default-free real interest rates tend to be relatively high in countries with high expected economic growth because investors:

A increase current borrowing.

B have high inter-temporal rates of substitution.

C have high uncertainty about levels of future consumption.

5 Positive output gaps are usually associated with:

A deflation.

B high unemployment.

C economic growth beyond sustainable capacity.

6 All else equal, an investor expects future inflation to increase, but the uncertainty of future inflation to fall. For such an investor the break-even inflation rate:

A is uncertain.

B is expected to fall.

C is expected to rise.

7 The difference between the yield on a zero-coupon, default-free nominal bond and the yield on a zero-coupon, default-free real bond of the same maturity reflects:

A investors' expectations about future inflation only.

B a premium for the uncertainty of future inflation only.

C both, investors' expectations about future inflation and a premium for the uncertainty of future inflation.

8 One interpretation of an upward sloping yield curve is that the returns to short-dated bonds are:

A uncorrelated with bad times.

B more positively correlated with bad times than are returns to long-dated bonds.

C more negatively correlated with bad times than are returns to long-dated bonds.

9 An analyst, who measures yield as a combination of interest rates and premiums, observes an upward-sloping, default-free government bond nominal yield curve. Which of the following statements is correct?

A Interest rates must be expected to rise in the future.

B Bond risk premiums must be expected to rise in the future.

C Expectations relating to the future direction of interest rates are indeterminate.

10 During a recession, the slope of the yield curve for default-free government bonds is *most likely* to:

A flatten.

B steepen.

C become inverted.

11 A corporate bond has a remaining maturity of 1 year, has a face value of EUR100, and is currently priced at EUR90.90. The real risk-free rate is 3.25%. Inflation is expected to be 2.0% next year, and the premium required by investors for inflation uncertainty is 0.25%.

The implied credit risk premium embedded in the bond's price is *best* described as:

A equal to (100/90.90) – 1 = 10%.

B 10% reduced by the real risk-free rate and expected inflation.

C 10% reduced by the real risk-free rate, expected inflation, and the premium for inflation uncertainty.

12 A decrease in the prices of AAA-rated corporate bonds during a recession would *most likely* be the result of:

A expectations of higher inflation.

B increases in credit risk premiums.

C increases in short-term, default-free interest rates.

13 During an economic period where spreads between corporate and government bonds are narrowing, and spreads between higher and lower rated corporate bond categories are also narrowing, it can be expected that:

A government bonds will outperform corporate bonds.

B lower rated corporate bonds will outperform higher rated corporate bonds.

C higher rated corporate bonds will outperform lower rated corporate bonds.

14 The sensitivity of a corporate bond's spread to changes in the business cycle is *most likely* to be:

A uncorrelated with the level of cyclicality in the company's business.

B positively correlated with the level of cyclicality in the company's business.

C negatively correlated with the level of cyclicality of the company's business.

15 The category of bonds whose spreads can be expected to widen the *most* during an economic downturn are bonds from the:

A cyclical sector with low credit ratings.

B cyclical sector with high credit ratings.

C non-cyclical sector with low credit ratings.

16 When assessing investment opportunities in equities, investors should:

A assign higher equity risk premiums to non-cyclical companies, relative to cyclical companies.

B forecast lower volatility in the growth rate of earnings for cyclical companies, relative to non-cyclical companies.

C forecast higher growth rates in earnings for cyclical companies coming out of a recession, relative to non-cyclical companies.

17 Risk-averse investors demanding a large equity risk premium are *most likely* expecting their future consumption outcomes and equity returns to be:

A uncorrelated.

B positively correlated.

C negatively correlated.

18 Which of the following financial assets is likely to offer the *most* effective hedge against bad consumption outcomes?

A Equities.

B Short-dated, default-free government bonds.

C Long-dated, default-free government bonds.

19 Other things equal, equilibrium price-to-earnings (P/E) ratios will *most likely* decrease if:

A real interest rates decrease.

B inflation is expected to increase.

C there is less uncertainty about future inflation.

20 Which of the following statements relating to commercial real estate is correct?

A Rental income from commercial real estate is generally unstable across business cycles.

B Commercial real estate investments generally offer a good hedge against bad consumption outcomes.

C The key difference in the discount rates applied to the cash flows of equity investments and commercial real estate investments relate to liquidity.

21 With regard to the credit risk of the sovereign debt issued by country governments, which of the following statements is correct? The credit risk premium on such debt is:

A zero because governments can print money to settle their debt.

B negligibly small because no country has defaulted on sovereign debt.

C a non-zero and positive quantity which varies depending on a country's creditworthiness.

The following information relates to Questions 22–28

Julie Carlisle is a financial planner at a large wealth management firm. One of her clients, Esteban Blake, just received a sizable inheritance. He invests a portion of the inheritance in an annuity that will immediately increase his income by a substantial amount. He enlists Carlisle's help to invest the remaining amount of the inheritance.

Blake informs Carlisle he would like some short-term bonds in his portfolio. Carlisle proposes purchasing a one-year domestic government zero-coupon bond. It has a face value of $100 and is currently priced at $96.37. Carlisle estimates the one-year real risk-free rate at 1.15% and expects inflation over the next year to be 2.25%.

In an effort to provide Blake with some exposure to international markets, Carlisle proposes three countries to look for investment opportunities. Selected data on the three countries are presented in Exhibit 1.

Exhibit 1 Selected Macroeconomic Data

	Nominal GDP Growth	Inflation Rate	Volatility of Real GDP Growth	Yield Curve Shape	Trailing 12-Month Equity Index P/E
Country #1	6.5%	4.0%	Low	Flat	16.5
Country #2	5.0%	2.5%	High	Upward slope	17.3
Country #3	3.5%	2.0%	Low	Flat	18.2

In her analysis, Carlisle observes that the spread between the three-year default-free nominal bond and the default-free real zero-coupon bond in Country #3 is 2.0%.

Blake expresses concern that stocks may be currently overvalued in Country #3 given the country's 20-year historical equity index P/E of 16.0. Carlisle comments:

> I think the equilibrium P/E in Country #3 has increased because of changes in market conditions.

Carlisle predicts that Country #3 will slip into a recession next quarter. She thinks it will be short-lived, lasting only 12 months or so, and considers the impact of such a recession on the performance of the country's stocks and bonds.

Exhibit 2 Three-Year Corporate Bonds from Country #3

Corporate Bond	Moody's Investors Service Rating	Spread*
Bond A	Aaa	1.4%
Bond B	Baa1	3.2%
Bond C	B3	5.3%

* Spread versus three-year sovereign bond

22 Holding all else constant, the change in Blake's income will *most likely* result in:

A an increase in his marginal utility of consumption.

B an increase in his intertemporal rate of substitution.

C a decrease in his required risk premium for investing in risky assets.

23 The implied premium for inflation uncertainty for the one-year government zero-coupon bond proposed by Carlisle is *closest* to:

A 0.23%.

B 0.37%.

C 1.10%.

24 Based on the data in Exhibit 1, current real short-term interest rates would *most likely* be highest in:

A Country #1.

B Country #2.

C Country #3.

25 The recent change in Country #3's breakeven inflation rate suggests that the expected rate of inflation over the next three years is:

A less than 2.0%.

B equal to 2.0%.

C greater than 2.0%.

26 Which of the following changes in market conditions *best* supports Carlisle's comment regarding the equilibrium P/E for Country #3?

A An increase in the equity risk premium

B A decrease in uncertainty about future inflation

C A decrease in expectation of future real earnings growth

27 If Carlisle's prediction about the economy of Country #3 is realized, the yield curve in Country #3 will *most likely*:

A remain flat.

B become upward sloping.

C become downward sloping.

28 Based on Exhibit 2, if Carlisle's prediction for Country #3 is realized, then over the next 12 months:

A Bond A would be expected to outperform Bond C.

B Bond B would be expected to outperform Bond A.

C Bond C would be expected to outperform Bond B.

SOLUTIONS

1 C is correct. According to the fundamental pricing equation, the market value of an asset is affected by economic factors that affect the asset's expected future cash flows, default-free interest rates, expected inflation rates or the asset's risk premium. From Equation 1 in Section 2.1, expected cash flows are in the numerator, while expected inflation and the real risk-free rate are in the denominator. Consequently, a rise in the real risk-free rate (the yield to maturity on a default-free instrument) will lead to a fall in the price of a risky asset like stock by increasing the rate at which its cash flows are discounted.

2 B is correct. Only changes in default-free real interest rates will affect the price of real, default-free bonds. The average level of default-free real interest rates is positively related to the volatility of economic growth in the economy; thus, changes in the expected volatility of economic growth would likely lead to changes in real default-free real interest rates, which in turn would affect the prices of real, default-free government bonds.

3 A is correct. For risk-averse investors, when the expected future price of the investment is high (low), the marginal utility of future consumption relative to that of current consumption is low (high). Hence, the covariance of the inter-temporal rate of substitution with asset price is expected to be negative for risk-averse investors.

4 A is correct. The average level of default-free real interest rates is positively related to the expected rate of growth of the underlying economy and also to the volatility of economic growth in the economy. During periods of high expected economic growth, investors are less worried about the future and their consumption abilities in the future—that is, their inter-temporal rate of substitution is low, so they borrow more today and save less. Other things being equal, this means that the average level of default-free real interest rates (the reciprocal of the rate of substitution, see Equation 4) should be higher in an economy with high growth, and lower in an economy with lower, more stable growth.

5 C is correct. An economy operating with a positive output gap—that is, where the level of actual GDP exceeds potential GDP—is producing beyond its sustainable capacity. Positive output gaps are usually associated with high and/or rising inflation, while high levels of unemployment usually accompany negative output gaps.

6 A is correct. The break-even inflation rate is the difference between the yield on a zero-coupon, default-free nominal bond and on a zero-coupon default-free, real bond of the same maturity. The rate incorporates changing expectations about inflation and changing perceptions about the uncertainty of the future inflation environment. Consequently, if inflation is expected to rise, while the uncertainty about future inflation falls, (in Equation 10, $\theta_{t,s}$ rises, but $\pi_{t,s}$ falls) it is unclear in which direction break-even inflation rates will move.

7 C is correct. The difference between the yield on a zero-coupon, default-free nominal bond and the yield on a zero-coupon, default-free real bond of the same maturity is known as the break-even inflation rate. This break-even inflation rate will incorporate the inflation expectations of investors over the investment horizon of the two bonds, plus a risk premium to compensate investors for uncertainty about future inflation. Break-even inflation rates are not simply

the markets' best estimate of future inflation over the relevant investment horizon, as break-even inflation rates also include a risk premium to compensate investors for their uncertainty about future inflation.

8 C is correct. One interpretation of an upward sloping yield curve is that returns to short-dated bonds are more negatively correlated with bad times than are returns to long-dated bonds. This interpretation is based on the notion that investors are willing to pay a premium and accept a lower return for short-dated bonds if they believe that long-dated bonds are not a good hedge against economic "bad times".

9 C is correct. An upward sloping yield curve may be caused by a combination of expected rate increases and positive bond risk premiums. It may also be a combination of expectations that interest rates will be unchanged in the future coupled with positive bond risk premiums. Lastly, an upward sloping yield curve may actually be a reflection of expected rate cuts that are more than offset by the existence of positive bond risk premiums. So, expectations relating to the future direction of interest rates are indeterminate.

10 B is correct. During a recession, short rates are often lower because central banks tend to lower their policy rate in these times because the output gap is likely to be negative. However, the impact of such monetary policy on longer-term rates will not be as strong, so long rates may not fall by as much as short rates. The central bank will usually be expected to bring short term rates back to normal as the recession recedes and the risk free rates will increase as economic growth recovers. Thus, the slope of the yield curve will typically steepen during a recession.

11 C is correct. The implied credit risk premium embedded in the bond's price is the yield (10%) less the default risk-free nominal interest rate, which includes a premium for inflation uncertainty. See Example 15. The credit risk premium can be calculated as 4.51% in this case:

$$\gamma_{t,s}^{i} = \frac{100}{90.90} - (1 + 0.0325 + 0.02 + 0.0025)$$

$$\gamma_{t,s}^{i} = 4.51\%$$

12 B is correct. During recessions, the risk premium that investors demand on financial assets, particularly those that are not default-free, such as corporate bonds, may rise because investors in general may be less willing and able to take on heightened default risk during such periods. Specifically, the credit risk premium demanded by investors tends to rise in times of economic weakness, when the probability of a corporate default and bankruptcy is highest.

13 B is correct. When spreads are narrowing, investors seem to be less discerning between issues with weak versus strong credit, and the rate of improvement will tend to be greater for those bonds issued by entities with a relatively weaker ability to pay. Thus, during times when corporate bond spreads are narrowing relative to government bonds, and the spreads between higher and lower rated bond categories also narrowing, corporate bonds will generally outperform government bonds, and lower rated corporate bonds will tend to outperform higher rated corporate bonds.

14 B is correct. The sensitivity of a corporate bond's spread to changes in the business cycle and the level of cyclicality tend to be positively correlated. The greater the level of cyclicality, the greater the sensitivity of the bond's spread to changes in the business cycle.

15 A is correct. During an economic downturn, the spreads of corporate bonds can be expected to widen, as the risk premium that investors demand on risky financial assets will increase. When spreads widen, the spreads on bonds issued by corporations with a low credit rating and that are part of the cyclical sector will tend to widen most.

16 C is correct. During recessions, cyclical companies are likely to experience sharp declines in earnings, more so than non-cyclical companies. In contrast, while coming out of a recession, cyclical companies are likely to generate higher earnings growth relative to non-cyclical companies.

17 B is correct. If investors demand high equity risk premiums, they are likely expecting their future consumption and equity returns to be positively correlated. The positive correlation indicates that equities will exhibit poor hedging properties, as equity returns will be high (e.g., pay off) during "good times" and will be low (e.g., not pay off) during "bad times". In other words, the covariance between risk-averse investors' inter-temporal rates of substitution and the expected future prices of equities is highly negative, resulting in a positive and large equity risk premium. This is the case because, in good times, when equity returns are high, the marginal value of consumption is low. Similarly, in bad times, when equity returns are low, the marginal value of consumption is high. Holding all else constant, the larger the magnitude of the negative covariance term, the larger the risk premium.

18 B is correct. The relative certainty about the real payoff from short-dated, default-free government bonds, and therefore the relative certainty about the amount of consumption that the investor will be able to undertake with the payoff, indicates that an investment in such bonds would be a good hedge against bad consumption outcomes.

19 B is correct. Other things being equal, an increase in inflation expectations would result in lower equity prices relative to current earnings. This would result in lower equilibrium P/E ratios.

20 C is correct. To arrive at an appropriate discount rate to be used to discount the cash flows from a commercial real estate investment, a liquidity premium is added to the discount rate applicable to equity investments. The added liquidity premium provides additional compensation for the risk that the real estate investment may be very illiquid in bad economic times.

21 C is correct. Credit premiums have been an important component of the expected return on bonds issued by countries (sovereign debt). The credit premium varies from country to country depending on how creditworthy investors consider it to be. The fact that countries have both printed money to pay back debt and/or defaulted on it gives rise to non-zero credit risk premium.

22 C is correct. The additional annuity payment substantially increases Blake's income and wealth, which decreases his marginal utility of consumption. As a result, the average loss of marginal utility from any risk taking decreases as his wealth increases. Thus, he requires a lower risk premium and is willing to buy more risky assets.

23 B is correct. The pricing equation for a default-free nominal coupon-paying bond is

$$P_t^i = \sum_{s=1}^{N} \frac{\mathrm{CF}_{t+s}^i}{\left(1 + l_{t,s} + \theta_{t,s} + \pi_{t,s}\right)^s}$$

For a one-year bond, the pricing formula reduces to

$$P_t = \frac{\mathrm{CF}_{t+1}}{\left(1 + l_{t,1} + \theta_{t,1} + \pi_{t,1}\right)^1}$$

Thus, the implied premium for inflation uncertainty for the one-year government zero-coupon bond is calculated as

$$\pi_{t,1} = \frac{\mathrm{CF}_{t+1}}{P_t} - \left(1 + l_{t,1} + \theta_{t,1}\right)$$

$$= \frac{100}{96.37} - \left(1 + 0.0115 + 0.0225\right)$$

$$= 1.0377 - 1.0340$$

$$= 0.0037, \text{ or } 0.37\%$$

24 B is correct. Real short-term interest rates are positively related to both real GDP growth and the volatility of real GDP growth. Country #1 and Country #2 have the highest real GDP growth, as estimated by the difference between nominal GDP growth and average inflation (6.5% – 4.0% = 2.5% and 5.0% – 2.5% = 2.5%, respectively), while Country #3 has the lowest real GDP growth (3.5% – 2.0% = 1.5%). Looking at the volatility of real GDP growth, Country #2 has high real GDP growth volatility, whereas Country #1 and Country #3 have low real GDP growth volatility. Therefore, Country #2 would most likely have the highest real short-term interest rates.

25 A is correct. The difference, or spread, between the yields on the country's three-year default-free nominal and on the default-free real zero-coupon bonds is 2.0%. This spread is known as the breakeven rate of inflation (BEI), which is composed of the expected rate of inflation plus a risk premium for the uncertainty of future inflation. Because this risk premium component is most likely positive, because investors are unlikely to be very confident in their ability to predict inflation accurately, the expected rate of inflation component would be less than 2.0%.

26 B is correct. Stock prices are a function of expected cash flows discounted by inflation expectations, the uncertainty of future inflation, and the equity risk premium, among other factors. Holding all else equal, a decline in the uncertainty of future inflation would result in lower discount rates and higher valuations. This result would support a higher equilibrium P/E, thus justifying Country #3's current trailing P/E being higher than its historical average.

27 B is correct. The yield curve in Country #3 is currently flat (Exhibit 1), and Carlisle predicts a recession. During a recession, short-term rates tend to be lower because central banks tend to lower their policy rate in these times. However, the impact of monetary policy on longer-term rates will not be as strong because the central bank will usually be expected to bring short-term rates back to normal as the recession recedes. Thus, the slope of the yield curve will likely become upward sloping during the recession.

28 A is correct. If Country #3 experiences a recession over the next 12 months, the credit spreads for corporate bonds would be expected to widen as investors sell the low-quality debt of issuers with high default risk and trade up to the higher-quality debt of issuers with low default risk. The issuers with a good credit rating (like Aaa rated Bond A) tend to outperform those with lower ratings (like B3 rated Bond C) as the spread between low and higher quality issuers widens. As a result, Bond A would be expected to outperform Bond C over the next 12 months.

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PRACTICE PROBLEMS

1 Wei Liu makes two statements about active portfolio management:

Statement 1 The "active return" of an actively managed portfolio is the difference between the portfolio's return and the return on the benchmark portfolio, and is equal to the managed portfolio's alpha.

Statement 2 The active weights are the differences in the managed portfolio's weights and the benchmark's weights.

Are Liu's statements correct?

A Only Statement 1 is correct.

B Only Statement 2 is correct.

C Both statements are correct.

2 The benchmark weights and returns for each of the five stocks in the Capitol index are given below. The Tukol Fund uses the Capitol Index as its benchmark, and the fund's portfolio weights are also shown in the table.

Stock	Portfolio Weight (%)	Benchmark Weight (%)	2016 Return (%)
1	30	24	14
2	30	20	15
3	20	20	12
4	10	18	8
5	10	18	10

What is the value added (active return) for the Tukol Fund?

A 0.00%

B 0.90%

C 1.92%

3 Consider the following asset class returns for calendar year 2016:

Asset class	Portfolio Weight (%)	Benchmark Weight (%)	Portfolio Return (%)	Benchmark Return (%)
Domestic equities	55	40	10	8
International equities	20	30	10	9
Bonds	25	30	5	6

What is the value added (or active return) for the managed portfolio?

A 0.25%

B 0.35%

C 1.05%

4 Gertrude Fischer mentions two properties of the Sharpe ratio and the information ratio that she says are very useful.

Property 1 The Sharpe ratio is unaffected by the addition of cash or leverage in a portfolio.

Property 2 The information ratio for an unconstrained portfolio is unaffected by the aggressiveness of the active weights.

Are Fischer's two properties correct?

A Yes.

B No. Only Property 1 is correct.

C No. Only Property 2 is correct.

The following information relates to Questions 5 and 6

	S&P 500	Indigo Fund
Expected annual return	9.0%	10.5%
Return standard deviation	18.0%	25.0%
Sharpe ratio	0.333	0.30
Active return		1.2%
Active risk		8.0%
Information ratio		0.15

5 What is the maximum Sharpe ratio that a manager can achieve by combining the S&P 500 benchmark portfolio and the Indigo Fund?

A 0.333

B 0.365

C 0.448

6 Which of the following pairs of weights would be used to achieve the highest Sharpe ratio and optimal amount of active risk through combining the Indigo Fund and benchmark portfolio, respectively?

A 1.014 on Indigo and –0.014 on the benchmark

B 1.450 on Indigo and –0.450 on the benchmark

C 1.500 on Indigo and –0.500 on the benchmark

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7 The benchmark portfolio is the S&P 500. Which of the following three portfolios can be combined with the benchmark portfolio to produce the highest combined Sharpe ratio?

	S&P 500	Portfolio A	Portfolio B	Portfolio C
Expected annual return	9.0%	10.0%	9.5%	9.0%
Return standard deviation	18.0%	20.0%	20.0%	18.0%
Sharpe ratio	0.333	0.350	0.325	0.333
Active return	0	1.0%	0.5%	0
Active risk	0	10.0%	3.0%	2.0%

A Portfolio A

B Portfolio B

C Portfolio C

8 Based on the fundamental law of active management, if a portfolio manager has an information ratio of 0.75, an information coefficient of 0.1819, and a transfer coefficient of 1.0, how many securities are in the portfolio manager's fund, making the assumption that the active returns are uncorrelated.

A About 2

B About 4

C About 17

9 Two analysts make the following statements about the transfer coefficient in the full fundamental law of active management:

Analyst One says, "The transfer coefficient measures how well the realized returns correlate with the anticipated returns, adjusted for risk."

Analyst Two says, "The transfer coefficient measures how well the realized returns correlate with the active weights, adjusted for risk."

Which, if either, analyst is correct?

A Only Analyst One is correct.

B Only Analyst Two is correct.

C Neither analyst is correct.

10 The full fundamental law of active management is stated as follows:

$$E(R_A) = (TC)(IC)\sqrt{BR}\,\sigma_A$$

Which component on the right hand side represents the extent to which the portfolio manager's expectations are realized? The

A transfer coefficient, TC.

B information coefficient, IC.

C breadth, BR.

11 An analyst is given the following information about a portfolio and its benchmark. In particular, the analyst is concerned that the portfolio is a closet index fund.[1] The T-bill return chosen to represent the risk-free rate is 0.50%.

	Benchmark	Portfolio
Return	8.75%	8.90%
Risk	17.50%	17.60%
Active Return	0.00%	0.15%
Active Risk	0.00%	0.79%
Sharpe Ratio	0.4714	0.4773
Information Ratio	N/A	0.1896

Which of the following three statements *does not* justify your belief that the portfolio is a closet index?

I. The Sharpe ratio of the portfolio is close to the Sharpe ratio of the benchmark.

II. The information ratio of the portfolio is relatively small.

III. The active risk of the portfolio is very low.

A Statement I

1 A closet index fund is a fund that advertises itself as being actively managed but is actually close to being an index fund.

B Statement II

C Statement III

12 You are considering three managers for a small cap growth mandate. After careful analysis, you produce the following forward looking expectations about the managers' active risk and active return:

	Manager A	Manager B	Manager C
Active Return	0.7%	0.6%	1.2%
Active Risk	3.2%	3.1%	6.3%

If you intend to rely on the information ratio to make your decision, which manager should you choose?

A Manager A

B Manager B

C Manager C

13 You have a portfolio 100% allocated to a manager with an ex-post active risk at 8.0%. You choose to allocate a 75% position to the active manager and 25% to the benchmark to bring the portfolio back to your target active risk of 6.0%. If the manager's information ratio is 0.50, what happens to the information ratio of the portfolio after the reallocation?

A The information ratio increases because the lower active risk reduces the denominator of the ratio.

B The information ratio remains unchanged because allocations between the active portfolio and the benchmark don't affect the information ratio.

C The information ratio decreases because allocating some of the portfolio to the benchmark means that the external manager generates less active return.

The following information relates to Questions 14 and 15

You are analyzing three investment managers for a new mandate. The table below provides the managers' ex-ante active return expectations and portfolio weights. The last two columns include the risk and the ex-post, realized active returns for the four stocks. Use the following data for the following two questions:

	Manager 1		Manager 2		Manager 3			
	Δw	$E(R_A)$	Δw	$E(R_A)$	Δw	$E(R_A)$	Risk	Realized R_A
Security 1	–0.125	0.03	0.2	0.04	–0.05	0.025	0.17	0.06
Security 2	0.025	0.04	0	0.01	0.05	0.015	0.10	0.07
Security 3	0.075	0.05	–0.1	0	0.05	0.005	0.12	0.04
Security 4	0.025	0.06	–0.1	0.02	–0.05	0.015	0.25	0.02

14 Suppose all three managers claim to be good at forecasting returns. According to the full fundamental law of active management, which manager is the best at efficiently building portfolios by anticipating future returns?

A Manager 1

B Manager 2

C Manager 3

15 Suppose all three managers claim to be efficient in portfolio construction. According to the full fundamental law of active management, which manager is the best at building portfolios to make full use of their ability to correctly anticipate returns?

A Manager 1

B Manager 2

C Manager 3

---

16 Manager 1 has an information coefficient of 0.15, a transfer coefficient of 1.0, and invests in 50 securities. Manager 2 has a different strategy, investing in more securities, but is subject to investment constraints that reduce his transfer coefficient. Manager 2 has an information coefficient of 0.10, a transfer coefficient of 0.8, and invests in 100 securities. The investment selections of each manager are independent decisions. If both managers target an active risk of 5.0%, which manager will have the greater expected active return?

A Manager 1

B Manager 2

C Both managers will have the same active return.

17 Nick Young is concerned that Goudon Partners, one of his money managers, overestimates its expected active return because Goudon overstates its strategy breadth. Young makes two notes about his concern:

Note 1 Although Goudon claims that the number of independent asset decisions is high because it uses 200 stocks, many of these stocks cluster in industries where the same general analysis applies to several stocks.

Note 2 Goudon claims that each stock is independent and evaluated each month, or 12 times per year. These analyses are not independent because some of their strategies, such as favoring a particular industry or favoring value stocks, persist beyond one month. For example, a strategy of favoring low-P/E stocks will persist for several months and the investment decisions are not independent.

If his judgments are correct, are Young's notes about the overstatement of breadth correct?

A Only Note 1 is correct.

B Only Note 2 is correct.

C Both Notes 1 and 2 are correct.

18 Caramel Associates uses the fundamental law to estimate its expected active returns. Two things have changed. First, Caramel will lower its estimate of the information coefficient because they felt their prior estimates reflected overconfidence. Second, their major clients have relaxed several constraints on their portfolios, including social screens, prohibitions on short selling, and constraints on turnover. Which of these changes will increase the expected active return?

A Only the lower information coefficient.

B Only the relaxation of several portfolio constraints.

C Both the lower information coefficient and the relaxation of portfolio constraints.

The following information relates to Questions 19–25

James Frazee is chief investment officer at H&F Capital Investors. Frazee hires a third-party adviser to develop a custom benchmark for three actively managed balanced funds he oversees: Fund X, Fund Y, and Fund Z. (Balanced funds are funds invested in equities and bonds.) The benchmark needs to be composed of 60% global equities and 40% global bonds. The third-party adviser submits the proposed benchmark to Frazee, who rejects the benchmark based on the following concerns:

Concern 1: Many securities he wants to purchase are not included in the benchmark portfolio.

Concern 2: One position in the benchmark portfolio will be somewhat costly to replicate.

Concern 3: The benchmark portfolio is a float-adjusted, capitalization-weighted portfolio.

After the third-party adviser makes adjustments to the benchmark to alleviate Frazee's concerns, Frazee accepts the benchmark portfolio. He then asks his research staff to develop risk and expected return forecasts for Funds X, Y, and Z as well as for the benchmark. The forecasts are presented in Exhibit 1.

Exhibit 1 Forecasted Portfolio Statistics for Funds X, Y, and Z and the Benchmark

	Fund X	Fund Y	Fund Z	Benchmark
Portfolio weights:				
Global equities (%)	60.0	65.0	68.0	60.0
Global bonds (%)	40.0	35.0	32.0	40.0
Expected return (%)	10.0	11.6	13.2	9.4
Expected volatility (%)	17.1	18.7	22.2	16.3
Active risk (%)	5.2	9.2	15.1	N/A
Sharpe ratio (SR)	0.45	0.50	0.49	0.44

Note: Data are based on a risk-free rate of 2.3%.

Frazee decides to add a fourth offering to his group of funds, Fund W, which will use the same benchmark as in Exhibit 1. Frazee estimates Fund W's information ratio to be 0.35. He is considering adding the following constraint to his portfolio construction model: Fund W would now have maximum over- and underweight constraints of 7% on single-country positions.

Frazee conducts a search to hire a manager for the global equity portion of Fund W and identifies three candidates. He asks the candidates to prepare risk and return forecasts relative to Fund W's benchmark based on their investment strategy, with

the only constraint being no short selling. Each candidate develops independent annual forecasts with active return projections that are uncorrelated and constructs a portfolio made up of stocks that are diverse both geographically and across economic sectors. Selected data for the three candidates' portfolios are presented in Exhibit 2.

Exhibit 2 Forecasted Portfolio Data for Equity Portion of Fund W

	Candidate A	Candidate B	Candidate C
Rebalancing	Annually	Annually	Annually
Number of securities	100	64	36
Information ratio (IR)	0.582	0.746	0.723
Transfer coefficient (TC)	0.832	0.777	0.548
Information coefficient*	0.07	0.12	0.22

* Information coefficient based on previously managed funds.

Frazee asks Candidate C to re-evaluate its portfolio data given the following changes:

Change 1: Fix the number of securities to 50.

Change 2: Rebalance on a semiannual basis.

Change 3: Add maximum over- or underweight constraints on sector weightings.

19 Which of Frazee's concerns *best* justifies his decision to reject the proposed benchmark?

A Concern 1

B Concern 2

C Concern 3

20 Based on Exhibit 1, the expected active return from asset allocation for Fund X is:

A negative.

B zero.

C positive.

21 Based on Exhibit 1, which fund is expected to produce the greatest consistency of active return?

A Fund X

B Fund Y

C Fund Z

22 Based on Exhibit 1, combining Fund W with a fund that replicates the benchmark would produce a Sharpe ratio *closest* to:

A 0.44.

B 0.56.

C 0.89.

23 If Frazee added the assumption he is considering in Fund W's portfolio construction, it would *most likely* result in:

A a decrease in the optimal aggressiveness of the active strategy.

B the information ratio becoming invariant to the level of active risk.

C an increase in the transfer of active return forecasts into active weights.

24 Based on the data presented in Exhibit 2, the candidate with the greatest skill at achieving active returns appears to be:

A Candidate A.

B Candidate B.

C Candidate C.

25 Which proposed change to Fund W would *most likely* decrease Candidate C's information ratio?

A Change 1

B Change 2

C Change 3

The following information relates to Questions 26–29

John Martinez is assessing the performance of the actively managed diversified asset portfolio. The diversified asset portfolio is invested in equities, bonds, and real estate, and allocations to these asset classes and to the holdings within them are unconstrained.

Selected return and financial data for the portfolio for 2015 are presented in Exhibit 1.

Exhibit 1 Diversified Asset Portfolio 2015 Portfolio Performance

	Subportfolio Return (%)	Benchmark Return (%)	Portfolio Allocation (%)	Strategic Asset Allocation (%)
Equities subportfolio	36.9	31.6	63	60
Bond subportfolio	–2.4	–2.6	28	35
Real estate subportfolio	33.4	28.3	9	5

Martinez uses several risk-adjusted return metrics to assess the performance of the diversified asset portfolio, including the information ratio and the Sharpe ratio. Selected risk, return, and statistical data for the portfolio are presented in Exhibit 2.

Exhibit 2 Diversified Asset Portfolio Data, 1996–2015

	Transfer Coefficient (TC)	Information Coefficient (IC)	Breadth (BR)
Equities subportfolio	0.90	0.091	21
Bond subportfolio	0.79	0.087	23
Real estate subportfolio	0.86	0.093	19

Martinez has recently hired Kenneth Singh to help him evaluate portfolios. Martinez asks Singh about the possible effects on the portfolio's information ratio if cash were added to the diversified asset portfolio or if the aggressiveness of the portfolio's active weights were increased. Singh responds with two statements:

Statement 1 Adding cash to the portfolio would change the portfolio's information ratio.

Statement 2 Increasing the aggressiveness of active weights would not change the portfolio's information ratio.

26 Based on Exhibit 1, the value added to the diversified asset portfolio attributable to the security selection decision in 2015 was *closest* to:

A 2.3%.

B 3.9%.

C 6.1%.

27 Based on Exhibit 1, the value added of the diversified asset portfolio attributable to the asset allocation decision in 2015 was *closest* to:

A 2.3%.

B 3.9%.

C 6.1%.

28 Based on data in Exhibit 2 and using the information ratio as the criterion for evaluating performance, which subportfolio had the best performance in the period 1996–2015?

A The bond subportfolio.

B The equities subportfolio.

C The real estate subportfolio.

29 Which of Singh's statements regarding the information ratio is correct?

A Only Statement 1

B Only Statement 2

C Both Statement 1 and Statement 2

SOLUTIONS

1 B is correct. Although the first part of Statement 1 is correct (active return, or value added, equals the difference between the managed portfolio return and the benchmark return), active return is not the same as alpha. In other words, $R_A = R_P - R_B$, while $\alpha_P = R_P - \beta_P \times R_B$. Statement 2 correctly defines active weights.

2 B is correct. The portfolio active return is equal to the portfolio return minus the benchmark return:

$$R_A = R_P - R_B$$

The portfolio return is $R_P = \sum_{i=1}^{n} w_{P,i} R_i$

$$R_P = 0.30(14\%) + 0.30(15\%) + 0.20(12\%) + 0.10(8\%) + 0.10(10\%) = 12.9\%.$$

The benchmark return is $R_B = \sum_{i=1}^{n} w_{B,i} R_i$

$$R_B = 0.24(14\%) + 0.20(15\%) + 0.20(12\%) + 0.18(8\%) + 0.18(10\%) = 12.0\%.$$

The active return is:

$$R_A = R_P - R_B = 12.9\% - 12.0\% = 0.9\%$$

Note that this same correct answer can be obtained in two other equivalent ways. The active weights are the differences between the portfolio and benchmark weights, or $\Delta w_i = w_{P,i} - w_{B,i}$. Computing the active weights from the table above, the active return is:

$$\begin{aligned} R_A &= \sum_{i=1}^{N} \Delta w_i R_i \\ &= 0.06(14\%) + 0.10(15\%) + 0(12\%) - 0.08(8\%) - 0.08(10\%) \\ &= 0.9\% \end{aligned}$$

Finally, we could express the active security returns as their differences from the benchmark return, or $R_{Ai} = R_i - R_B$. Computing the active security returns from the table above, the portfolio active return is the sum product of the active weights and the active security returns:

$$\begin{aligned} R_A &= \sum_{i=1}^{N} \Delta w_i R_{Ai} \\ &= 0.06(2\%) + 0.10(3\%) + 0(0\%) - 0.08(-4\%) - 0.08(-2\%) \\ &= 0.9\% \end{aligned}$$

3 C is correct. The active return is equal to the portfolio return minus the benchmark return:

$$R_A = R_P - R_B = \sum_{j=1}^{M} w_{P,j} R_{P,j} - \sum_{j=1}^{M} w_{B,j} R_{B,j}$$

The portfolio return is $R_P = \sum_{i=1}^{n} w_{P,i} R_i = 0.55(10\%) + 0.20(10\%) + 0.25(5\%) = 8.75\%$

The benchmark return is $R_B = \sum_{i=1}^{n} w_{B,i} R_i = 0.40(8\%) + 0.30(9\%) + 0.30(6\%) = 7.70\%$

$R_A = R_P - R_B = 8.75\% - 7.70\% = 1.05\%$

4 A is correct. Both properties are correct. For Property 1, if w_P is the weight of an actively managed portfolio and $(1 - w_P)$ is the weight on risk-free cash, changing w_P does not change the Sharpe ratio, as can be seen in this equation.

$$SR_C = \frac{R_C - R_F}{STD(R_C)} = \frac{w_P(R_P - R_F)}{w_P STD(R_P)} = SR_P$$

For Property 2, the information ratio of an unconstrained portfolio is unaffected by multiplying the active security weights, Δw_i by a constant.

5 B is correct. The highest squared Sharpe ratio of an actively managed portfolio is:

$$SR_P^2 = SR_B^2 + IR^2 = 0.333^2 + 0.15^2 = 0.1334$$

The highest Sharpe ratio is $SR_P = \sqrt{0.1334} = 0.365$

6 A is correct. The optimal amount of active risk is:

$$STD(R_A) = \frac{IR}{SR_B} STD(R_B) = \frac{0.15}{0.333} 18.0\% = 8.11\%$$

The weight on the active portfolio (Indigo) would be 8.11%/8.0% = 1.014 and the weight on the benchmark portfolio would be 1 − 1.014 = −0.014.

We can demonstrate that these weights achieve the maximum Sharpe ratio (of 0.365). Note that 8.11% is the optimal level of active risk, and that Indigo has an expected active return of 1.014(1.2%) = 1.217% over the benchmark (and a total excess return of 6.0% + 1.217% = 7.217%. The portfolio total risk is

$$STD(R_P)^2 = STD(R_B)^2 + STD(R_A)^2 = 18.0^2 + 8.111^2 = 389.788$$

Taking the square root, $STD(R_P) = 19.743$, and the optimal Sharpe ratio is indeed 7.217/19.743 = 0.365.

7 B is correct. The active portfolio that is optimal is the portfolio with the highest Information ratio, the ratio of active return to active risk. The IRs for the three active portfolios are:

$IR_A = 1.0/10.0 = 0.10$

$IR_B = 0.\ 5/3.0 = 0.167$

$IR_C = 0/2.0 = 0.00$

Portfolio B has the highest IR and is the best active portfolio; it is therefore the best portfolio to combine with the benchmark.

8 C is correct. Using the equation $IR^* = IC \times \sqrt{BR}$ and assuming that breadth can be interpreted as number of securities in the portfolio, solving for breadth in the equation above yields $\left(\frac{0.75}{0.1819}\right)^2 = 17.000$.

9 C is correct. The transfer coefficient measures how well the anticipated (ex-ante), risk adjusted returns correlate with the risk-adjusted active weights. This is also expressed in the equation for the transfer coefficient: $TC = COR(\mu_i/\sigma_i, \Delta w_i \sigma_i)$.

10 B is correct. The IC measures an investment manager's ability to forecast returns.

11 B is correct. A closet index will have a very low active risk and will also have a Sharpe ratio very close to the benchmark. Therefore, Statements I and III are consistent with a closet index portfolio. A closet index's information ratio can be indeterminate (because the active risk is so low), and often negative due to management fees.

12 A is correct. Manager A has the highest information ratio. The information ratio is defined as $\text{IR} = \frac{\text{active return}}{\text{active risk}}$. The managers in this example have the following information ratios:

	Manager A	Manager B	Manager C
Information ratio	0.7/3.2 = 0.219	0.6/3.1 = 0.194	1.2/6.3 = 0.190

13 B is correct. The information ratio is unaffected by rebalancing the active portfolio and the benchmark portfolio. In this case, the active return and active risk are both reduced by 25%, and the information ratio will be unchanged.

14 C is correct. The proper statistic to calculate is the information coefficient, and it is defined as follows:

$$\text{IC} = \text{COR}\left(\frac{R_{Ai}}{\sigma_i}, \frac{\mu_i}{\sigma_i}\right)$$

A manager is a good forecaster if his or her ex-ante active return expectations (forecasts) are highly correlated with the realized active returns. The information coefficient requires that these forecasts and realized returns be risk-weighted. When this is done for the three managers, the risk-weighted forecasts and realized returns are:

	Risk-weighted forecasts, μ_i/σ_i			R_{Ai}/σ_i
	Manager 1	Manager 2	Manager 3	Realized
Security 1	0.176	0.235	0.147	0.353
Security 2	0.400	0.100	0.150	0.700
Security 3	0.417	0.000	0.042	0.333
Security 4	0.240	0.080	0.060	0.080

The ICs are found by calculating the correlations between each manager's forecasts and the realized risk-weighted returns. The three managers have the following ICs:

	Manager 1	Manager 2	Manager 3
Information coefficient	0.5335	0.0966	0.6769

Manager 3 has the highest IC.

15 B is correct. The proper statistic to calculate is the transfer coefficient and it is defined as follows:

$$\text{TC} = \text{COR}(\mu_i/\sigma_i, \Delta w_i \sigma_i)$$

The TC is the cross-sectional correlation between the forecasted active security returns and the actual active weights, adjusted for risk.

	Risk-weighted forecasts, μ_i/σ_i			Risk-adjusted weights, $\Delta w_i\sigma_i$		
	Manager 1	Manager 2	Manager 3	Manager 1	Manager 2	Manager 3
Security 1	0.1765	0.2353	0.1471	–0.0213	0.0340	–0.0085
Security 2	0.4000	0.1000	0.1500	0.0025	0.0000	0.0050
Security 3	0.4167	0.0000	0.0417	0.0090	–0.0120	0.0060
Security 4	0.2400	0.0800	0.0600	0.0063	–0.0250	–0.0125

The three managers have the following TCs:

	Manager 1	Manager 2	Manager 3
Transfer coefficient	0.7267	0.8504	–0.0020

Manager 2 has the highest TC.

16 A is correct. Manager 1's IR = TC × IC × $\sqrt{\text{BR}}$ = 1.0 × 0.15 × $\sqrt{50}$ = 1.06. Manager 2's IR = 0.8 × 0.10 × $\sqrt{100}$ = 0.80. Manager 1's active return is 1.06(5.0) = 5.3% and Manager 2's expected active return is 0.80(5.0) = 4.0%. Manager 1 has the greater expected active return.

17 C is correct. If the decisions about each of the 200 stocks are not independent, and if the decisions about a stock from one month to the next are not independent, then Goudon Partners is overstating its estimates of its breadth and its expected active returns.

18 B is correct. Although the relaxation of portfolio constraints will increase the transfer coefficient (and expected active returns), the lower information coefficient reduces the information ratio and the expected active return.

19 A is correct. Because the benchmark does not contain many assets that Frazee wants to invest in, the benchmark may not be representative of his investment approach. Concern 2, as stated, is less important because it does not imply that the cost of replicating the benchmark is a serious concern. Finally, Concern 3 actually states a generally positive feature of the benchmark.

20 B is correct. Active return from asset allocation is derived from differences between the benchmark weight and the portfolio weight across asset classes. For Fund X, the expected active return from asset allocation is calculated as:

$$\text{Active Return from Asset Allocation} = \sum_{j=1}^{M} \Delta w_j R_{B,j} = (60 - 60)R_{B,e} + (40 - 40)R_{B,b} = 0$$

Where Δw_j is the difference in the active portfolio and the benchmark asset weights, $R_{B,e}$ is the benchmark's return from global equities, and $R_{B,b}$ is the benchmark's return from global bonds.

Because Fund X has the same asset weights as the benchmark across the two asset classes (60% global equities, 40% global bonds), the expected active return from asset allocation is zero.

21 C is correct. The IR measures the consistency of active return. The IR is calculated for the three funds as follows:

$$\text{IR} = \frac{R_P - R_B}{\text{STD}(P_P - R_B)} = \frac{R_A}{\text{STD}(R_A)}$$

IR for Fund X = (10.0 – 9.4)/5.2 = 0.6/5.2 = 0.12

IR for Fund Y = (11.6 – 9.4)/9.2 = 2.2/9.2 = 0.24

IR for Fund Z = (13.2 – 9.4)/15.1 = 3.8/15.1 = 0.25

Fund Z has the largest IR and thus is expected to produce the greatest consistency of active return.

22 B is correct. Given the IR for Fund W of 0.35 and the benchmark's SR of 0.44, the combination of the benchmark portfolio and Fund W would produce an SR of 0.55, calculated as follows:

$$SR_P^2 = SR_B^2 + IR^2$$

$$SR_P = (0.44^2 + 0.35^2)^{0.5} = 0.56$$

23 A is correct. The new assumption adds constraints to Fund W. The IR for a constrained portfolio generally decreases with the aggressiveness of the strategy because portfolio constraints reduce the transfer of active return forecasts into active weights. Furthermore, the optimal active risk is given by the following formula:

$$\sigma_A = TC\frac{IR}{SR_B}\sigma_B$$

The addition of portfolio constraints reduces the TC, thus also reducing the optimal active risk.

So, having maximum over- and underweight constraints on single-country positions decreases the optimal aggressiveness of the active management strategy.

24 B is correct. The IR measures the consistency of active return generation. A higher ratio generally indicates better managerial skill at achieving active returns on a risk-adjusted basis. The IR for Candidate B (0.746) is higher than the IR for Candidate A (0.582) and Candidate C (0.723).

Thus, Candidate B appears to have the greatest skill as indicated by the highest IR of 0.746.

25 C is correct. The IR is calculated as $IR = (TC)(IC)\sqrt{BR}$, where BR is breadth.

Change 3, establishing new constraints of caps on the over- and underweight of sectors, reduces the correlation of optimal active weights with the actual active weights, which results in a decreased TC and thus a decrease in the IR. Change 1 (increasing portfolio size from 36 to 50) and Change 2 (increasing the frequency of rebalancing from annually to semiannually) would both likely have the effect of increasing the BR of the portfolio, which would increase the IR.

26 B is correct. Based on the differences in returns for the portfolio and benchmark in Exhibit 1, the value added by each asset class within the portfolio is shown in the following table:

	Subportfolio Return (%)	Benchmark Return (%)	Value Added (%)	Portfolio Allocation (%)
Equities subportfolio	36.9	31.6	5.3	63
Bond subportfolio	–2.4	–2.6	0.2	28
Real estate subportfolio	33.4	28.3	5.1	9

The value added from security selection is calculated as the sum of the actual portfolio weights multiplied by each subportfolio's value added measure. Thus, the value added from security selection is calculated as: Value added from security selection = 0.63(5.3%) + 0.28(0.2%) + 0.09(5.1%) = 3.9%.

A is incorrect. It represents the value added from asset allocation.

C is incorrect. It represents the total value added (3% + 3.9% = 6.1%).

27 A is correct. The value added from asset allocation is calculated as the sum of the differences in the weights between the strategic (benchmark) allocation and the actual subportfolio allocation multiplied by each subportfolio's benchmark return.

	Benchmark Return (%)	Actual Asset Allocation (%)	Strategic Asset Allocation (%)	Actual – Strategic Asset Allocation (%)
Equities subportfolio	31.6	63	60	+3
Bond subportfolio	–2.6	28	35	–7
Real estate subportfolio	28.3	9	5	+4

Thus, the value added by the active asset allocation decision is calculated as:

Value added from asset allocation decision = 0.03(31.6%) – 0.07(–2.6%) + 0.04(28.3%) = 2.3%.

B is incorrect. It is the value added from security selection.

C is incorrect. It is the total value added.

28 B is correct. The information ratio for a portfolio can be expressed as follows:

$$\text{IR} = (\text{TC})(\text{IC})\sqrt{\text{BR}}$$

The information ratios for the three subportfolios are calculated as follows:

	Information Ratio
Equities subportfolio	$0.90 \times 0.091 \times (21)^{0.5} = 0.38$
Bond subportfolio	$0.79 \times 0.087 \times (23)^{0.5} = 0.33$
Real estate subportfolio	$0.86 \times 0.093 \times (19)^{0.5} = 0.35$

Based on the information ratio, the equities subportfolio outperformed the real estate subportfolio. The information ratio for the equities subportfolio of 0.38 was higher than the information ratio for the real estate subportfolio of 0.35 and the bond subportfolio of 0.33.

29 C is correct. The information ratio for a portfolio of risky assets will generally shrink if cash is added to the portfolio. Because the diversified asset portfolio is an unconstrained portfolio, its information ratio would be unaffected by an increase in the aggressiveness of active weights.

PRACTICE PROBLEMS

The following information relates to Questions 1–10

Brian Johnson is a senior manager at Star Asset Management (SAMN), a large asset management firm in the United States. Tim Martin has just earned his advanced degree in statistics and was hired to support the trading team at SAMN. Martin meets with Johnson to undergo a training relating to SAMN's trading activities.

Johnson begins the training with a review of the limit order book for Light Systems, Inc., which is presented in Exhibit 1. Three dealers make market for the shares of Light Systems. Based on these prices, SAMN's trading desk executes a market sell order for 1,100 shares of Light Systems.

Exhibit 1 Limit Order Book for Light Systems, Inc.

Bid				Ask			
Dealer	Time Entered	Price	Size	Dealer	Time Entered	Price	Size
B	10.10 a.m.	$17.15	900	C	10.11 a.m.	$17.19	1,200
C	10.11 a.m.	$17.14	1,500	B	10.10 a.m.	$17.20	800
A	10.11 a.m.	$17.12	1,100	A	10.12 a.m.	$17.22	1,100

Johnson then discusses a market buy order for 5,000 shares of an illiquid stock. The order was filled in three trades, and details about the three trades are presented in Exhibit 2.

Exhibit 2 Buy Trade Order Details

Trade #	Time	Trade Price	Trade Size	Bid Price	Ask Price
1	9.45 a.m.	$25.20	1,200	$25.17	$25.20
2	9.55 a.m.	$25.22	1,300	$25.19	$25.22
3	11.30 a.m.	$25.27	2,500	$25.22	$25.26

Johnson explains to Martin that the number of venues trading the same instruments has proliferated in recent years, and trading in any given instrument has now been distributed across these multiple venues. As a result, the available liquidity on any one of those exchanges represents just a small portion of the aggregate liquidity for that security. As a result, SAMN has had to adapt its trading strategies, particularly for large trades.

Johnson asks Martin about his views on how the introduction of electronic trading might have impacted SAMN. Martin tells Johnson:

Statement 1 Once built, electronic trading systems are more efficient and cheaper to operate than floor-based trading systems.

Statement 2 Electronic trading systems have attracted a lot of new buy-side traders, and the increased competition has resulted in narrower bid–ask spreads.

Statement 3 The introduction of electronic markets has had a much greater impact on the trading of corporate and municipal bonds than on the trading of equities.

Johnson tells Martin that communication speed is SAMN's current highest priority. All of SAMN's competitors have increased their communication speeds in recent months, and Johnson says management wants SAMN to be faster than its competitors. SAMN's trading desk is located in a residential area far from downtown where the exchanges it works with are located. SAMN's trading team is relatively large with experienced investment professionals, and the firm recently invested in fast computers with the latest algorithms.

At the end of the training, Johnson gives Martin his first assignment. The assignment is for Martin to use the vast amount of data that SAMN has collected to design a machine learning (ML) model using advanced statistical methods to characterize data structures and relations. Then he has to build a trading algorithm based on the same model. Since electronic trading has added systemic risk to the market, Johnson asks Martin to suggest ways to minimize the systemic risk introduced by his algorithm. Martin offers two suggestions:

Suggestion 1 Perform extensive testing of the algorithm before its launch.

Suggestion 2 Impose mandatory trading halts if prices change outside a threshold range.

A month into the job, Johnson sends Martin to an investment conference focused on abusive trading practices. Based on what he learned at the conference, Martin recommends to Johnson that SAMN incorporate a new rule that news be validated before a trade triggered by news is executed.

1 Based on Exhibit 1, the inside bid–ask spread for the limit order book for Light Systems is *closest* to:

A $0.04.

B $0.07.

C $0.10.

2 Based on Exhibit 1, the total amount that SAMN will receive, on a per share basis, for executing the market sell order is *closest* to:

A $17.14.

B $17.15.

C $17.22.

3 Based on Exhibit 2, the market impact relating to Trade 2, on a per share basis, is *closest* to:

A $0.02.

B $0.03.

C $0.07.

4 Based on Exhibit 2, the average effective spread of the three trades is *closest to*:

A $0.0333.

B $0.0367.

C $0.0400.

5 The reason for SAMN having to adapt its trading strategies is a result of:

A latency.

B market fragmentation.

C high frequency trading.

6 Which of Martin's statements relating to the introduction of electronic markets is correct?

A Statement 1

B Statement 2

C Statement 3

7 Which of the following changes should SAMN make to address its key priority?

A Hire more investment professionals

B Upgrade to more complex operating systems

C Move the trading desk physically closer to the exchanges it works with

8 The model that Martin is tasked with designing will likely be *most* effective:

A for testing new markets.

B in a well-understood market environment.

C during periods of higher than normal market volatility.

9 Which of Martin's suggestions will *most likely* be effective in limiting the systemic risk introduced by his algorithm?

A Only Suggestion 1

B Only Suggestion 2

C Both Suggestion 1 and Suggestion 2

10 Which market manipulation strategy is *most likely* the target of the new rule suggested by Martin?

A Rumormongering

B Gunning the market

C Trading for market impact

SOLUTIONS

1 A is correct. The inside bid–ask spread, or market bid–ask spread, is the difference between the highest bid price and the lowest ask price. The highest bid price for Light Systems is $17.15, and the lowest ask price is $17.19. Therefore, the inside bid–ask spread = $17.19 – $17.15 = $0.04.

2 B is correct. SAMN's trading desk executes a market sell order for 1,100 shares. Based on the limit order book, the trader would first sell 900 shares at $17.15 (highest bid, Dealer B) and then sell the remaining 200 shares at $17.14 (second highest bid, Dealer C). Therefore, the approximate price per share received by SAMN for selling the 1,100 shares is equal to [(900 × $17.15) + (200 × $17.14)] / 1,100 = $17.1482 per share ($17.15 rounded).

3 A is correct. Market impact, or price impact, is the effect of a trade on transaction prices. After the first trade (Trade 1) was executed at $25.20, Trade 2 was executed at $25.22, which is $0.02 per share higher than the trade price of Trade 1. So, the execution of Trade 1 led to a price impact of $0.02 per share on Trade 2.

4 C is correct. The effective bid–ask spread for buy orders is calculated as:

Effective bid–ask spread (buy order) = 2 × {Trade price – [(Ask price + Bid price) / 2)]} or
= 2 × (Trade price – Midpoint of the market at the time an order is entered).

So, the effective bid–ask spreads for the three buy trades are calculated as:

Effective spread of Trade 1 = 2 × {$25.20 – [($25.20 + $25.17)/2]} = $0.0300.

Effective spread of Trade 2 = 2 × {$25.22 – [($25.22 + 25.19)/2]} = $0.0300.

Effective spread of Trade 3 = 2 × {$25.27 – [($25.26 + $25.22)/2]} = $0.0600.

The resulting average effective spread is then calculated as:

Average effective spread = (Effective spread of Trade 1 + Effective spread of Trade 2 + Effective spread of Trade 3)/3.

Average effective spread = ($0.0300 + $0.0300 + $0.0600)/3 = $0.0400.

5 B is correct. According to Johnson, markets have become increasingly fragmented as the number of venues trading the same instruments has proliferated and trading in any given instrument has been split (or fragmented) across these multiple venues. As a result, the available liquidity on any one exchange represents just a small portion of the aggregate liquidity for that instrument. This phenomenon is known as market fragmentation and creates the potential for price and liquidity disparities across venues. As a result, SAMN has had to adapt its trading strategies to this fragmented liquidity to avoid intensifying the market impact of a large trade.

6 A is correct. Once built, electronic systems are indeed cheaper to operate than floor-based trading systems. They require less physical space than do trading floors, and in contrast to floor-based trading systems, they do not require exchange officials to record and report prices. Furthermore, the widespread use of electronic trading systems significantly decreased trading costs for buy-side traders. Costs fell as exchanges obtained greater cost efficiencies from using

electronic matching systems instead of floor-based manual trading systems. These technologies also decreased costs and increased efficiencies for the dealers and arbitrageurs who provide much of the liquidity offered at exchanges. Competition forced them to pass along much of the benefits of their new technologies to buy-side traders in the form of narrower spreads quoted for larger sizes. New electronic buy-side order management systems also decreased buy-side trading costs by allowing a smaller number of buy-side traders to process more orders and to process them more efficiently than manual traders.

While electronic trading has had a significant effect on equity markets, it has not had as much of an effect on the markets for corporate and municipal bonds. The market structures of corporate and municipal bond markets have hardly changed since the late 19th century. Despite the efforts of many creative developers of electronic bond trading systems, most public investors in these markets still trade largely over the counter with dealers.

7 C is correct. The speed required by electronic traders is affected by fast communication and fast computations. The shorter the distance between the trader and the exchange, the faster the communication. Many exchanges allow electronic traders to place their servers in the rooms where the exchange servers operate, a practice called collocation.

8 B is correct. Many trading problems are ideally suited for machine learning analyses because the problems repeat regularly and often. For such problems, machine-based learning systems can be extraordinarily powerful. However, these systems are often useless—or worse—when trading becomes extraordinary, as when volatilities shoot up. Machine learning systems frequently do not produce useful information during volatility episodes because they have few precedents from which the machines can learn. Thus, traders often instruct their electronic trading systems to stop trading—and sometimes to close out their positions—whenever they recognize that they are entering uncharted territory. Many traders shut down when volatility spikes—both because high-volatility episodes are uncommon and thus not well understood and because even if such episodes were well understood, they represent periods of exceptionally high risk.

9 C is correct. Both suggestions will likely be effective in minimizing the systemic risk introduced by electronic trading. First, exhaustive testing of the algorithm prior to its launch can minimize risk relating to programming errors, which could result in an extreme market reaction that could trigger an even more extreme market reaction. Second, imposing mandatory trade halts in case of large price changes (outside a given threshold) would limit potential undesired results and help minimize systemic risk.

10 A is correct. Rumormongering is the dissemination of false information about fundamental values or about other traders' trading intentions in an attempt to alter investors' value assessments. Martin's suggested news validation rule would reduce the likelihood that SAMN would be adversely affected by this market manipulation strategy.