GARP | FRM

# 2016 FRM® Part I Practice Exam

## Table of Contents

# Introduction

The FRM Exam is a practice-oriented examination. Its questions are derived from a combination of theory, as set forth in the core readings, and "real-world" work experience. Candidates are expected to understand risk management concepts and approaches and how they would apply to a risk manager's day-to-day activities.

The FRM Exam is also a comprehensive examination, testing a risk professional on a number of risk management concepts and approaches. It is very rare that a risk manager will be faced with an issue that can immediately be slotted into one category. In the real world, a risk manager must be able to identify any number of risk-related issues and be able to deal with them effectively.

The 2016 FRM Part I and Part II Practice Exams have been developed to aid candidates in their preparation for the FRM Exam in May and November 2016. These Practice Exams are based on a sample of questions from prior FRM Exams and are suggestive of the questions that will be in the 2016 FRM Exam.

The 2016 FRM Part I Practice Exam contains 100 multiple-choice questions and the 2016 FRM Part II Practice Exam contains 80 multiple-choice questions, the same number of questions that the actual 2016 FRM Exam Part I and 2016 FRM Exam Part II will contain. As such, the Practice Exams were designed to allow candidates to calibrate their preparedness both in terms of material and time.

The 2016 FRM Practice Exams do not necessarily cover all topics to be tested in the 2016 FRM Exam as any test samples from the universe of testable possible knowledge points. However, the questions selected for inclusion in the Practice Exams were chosen to be broadly reflective of the material assigned for 2016 as well as to represent the style of question that the FRM Committee considers appropriate based on assigned material.

For a complete list of current topics, core readings, and key learning objectives candidates should refer to the 2016 FRM Exam Study Guide and 2016 FRM Learning Objectives.

Core readings were selected by the FRM Committee to assist candidates in their review of the subjects covered by the Exam. Questions for the FRM Exam are derived from the core readings. It is strongly suggested that candidates study these readings in depth prior to sitting for the Exam.

**Suggested Use of Practice Exams**

To maximize the effectiveness of the practice exams, candidates are encouraged to follow these recommendations:

1. **Plan a date and time to take the practice exam.**
   Set dates appropriately to give sufficient study/review time for the practice exam prior to the actual exam.
2. **Simulate the test environment as closely as possible.**
   - Take the practice exam in a quiet place.
   - Have only the practice exam, candidate answer sheet, calculator, and writing instruments (pencils, erasers) available.
   - Minimize possible distractions from other people, cell phones, televisions, etc.; put away any study material before beginning the practice exam.
   - Allocate 4 hours to complete FRM Part I Practice Exam and 4 hours to complete FRM Part II Practice Exam and keep track of your time. The actual FRM Exam Part I and FRM Exam Part II are 4 hours each.

- Complete the entire exam and answer all questions. Points are awarded for correct answers. There is no penalty on the FRM Exam for an incorrect answer.
- Follow the FRM calculator policy. Candidates are only allowed to bring certain types of calculators into the exam room. The only calculators authorized for use on the FRM Exam in 2016 are listed below; there will be no exceptions to this policy. You will not be allowed into the exam room with a personal calculator other than the following: Texas Instruments BA II Plus (including the BA II Plus Professional), Hewlett Packard 12C (including the HP 12C Platinum and the Anniversary Edition), Hewlett Packard 10B II, Hewlett Packard 10B II+ and Hewlett Packard 20B.

**3. After completing the FRM Practice Exams**

- Calculate your score by comparing your answer sheet with the practice exam answer key.
- Use the practice exam Answers and Explanations to better understand the correct and incorrect answers and to identify topics that require additional review. Consult referenced core readings to prepare for the exam.
- Remember: pass/fail status for the actual exam is based on the distribution of scores from all candidates, so use your scores only to gauge your own progress and level of preparedness.

# 2016 Practice Exam, Part I – Candidate Answer Sheet

| | | | |
|---|---|---|---|
| 1.____________ | 26.____________ | 51.____________ | 76.____________ |
| 2.____________ | 27.____________ | 52.____________ | 77.____________ |
| 3.____________ | 28.____________ | 53.____________ | 78.____________ |
| 4.____________ | 29.____________ | 54.____________ | 79.____________ |
| 5.____________ | 30.____________ | 55.____________ | 80.____________ |
| 6.____________ | 31.____________ | 56.____________ | 81.____________ |
| 7.____________ | 32.____________ | 57.____________ | 82.____________ |
| 8.____________ | 33.____________ | 58.____________ | 83.____________ |
| 9.____________ | 34.____________ | 59.____________ | 84.____________ |
| 10.____________ | 35.____________ | 60.____________ | 85.____________ |
| 11.____________ | 36.____________ | 61.____________ | 86.____________ |
| 12.____________ | 37.____________ | 62.____________ | 87.____________ |
| 13.____________ | 38.____________ | 63.____________ | 88.____________ |
| 14.____________ | 39.____________ | 64.____________ | 89.____________ |
| 15.____________ | 40.____________ | 65.____________ | 90.____________ |
| 16.____________ | 41.____________ | 66.____________ | 91.____________ |
| 17.____________ | 42.____________ | 67.____________ | 92.____________ |
| 18.____________ | 43.____________ | 68.____________ | 93.____________ |
| 19.____________ | 44.____________ | 69.____________ | 94.____________ |
| 20.____________ | 45.____________ | 70.____________ | 95.____________ |
| 21.____________ | 46.____________ | 71.____________ | 96.____________ |
| 22.____________ | 47.____________ | 72.____________ | 97.____________ |
| 23.____________ | 48.____________ | 73.____________ | 98.____________ |
| 24.____________ | 49.____________ | 74.____________ | 99.____________ |
| 25.____________ | 50.____________ | 75.____________ | 100.____________ |

1. A risk manager is deciding between buying a futures contract on an exchange and buying a forward contract directly from a counterparty on the same underlying asset. Both contracts would have the same maturity and delivery specifications. The manager finds that the futures price is less than the forward price. Assuming no arbitrage opportunity exists, what single factor acting alone would be a realistic explanation for this price difference?

   **a.** The futures contract is more liquid and easier to trade.
   **b.** The forward contract counterparty is more likely to default.
   **c.** The asset is strongly negatively correlated with interest rates.
   **d.** The transaction costs on the futures contract are less than on the forward contract.

2. A trader in the arbitrage unit of a multinational bank finds that an asset is trading at USD 1,000, the price of a 1-year futures contract on that asset is USD 1,010, and the price of a 2-year futures contract is USD 1,025. Assume that there are no cash flows from the asset for 2 years. If the term structure of interest rates is flat at 1% per year, which of the following is an appropriate arbitrage strategy?

   **a.** Short 2-year futures and long 1-year futures
   **b.** Short 1-year futures and long 2-year futures
   **c.** Short 2-year futures and long the underlying asset funded by borrowing for 2 years
   **d.** Short 1-year futures and long the underlying asset funded by borrowing for 1 year

3. The price of a six-month, USD 25 strike price, European call option on a stock is USD 3. The stock price is USD 24. A dividend of USD 1 is expected in three months. The continuously compounded risk-free rate for all maturities is 5% per year. Which of the following is closest to the value of a put option on the same underlying stock with a strike price of USD 25 and a time to maturity of six months?

   **a.** USD 3.60
   **b.** USD 2.40
   **c.** USD 4.37
   **d.** USD 1.63

4. Which of the following statements regarding the trustee named in a corporate bond indenture is correct?

   **a.** The trustee has the authority to declare a default if the issuer misses a payment.
   **b.** The trustee may take action beyond the indenture to protect bondholders.
   **c.** The trustee must act at the request of a sufficient number of bondholders.
   **d.** The trustee is paid by the bondholders or their representatives.

**5.** Pear, Inc. is a manufacturer that is heavily dependent on plastic parts shipped from Malaysia. Pear wants to hedge its exposure to plastic price shocks over the next 7 ½ months. Futures contracts, however, are not readily available for plastic. After some research, Pear identifies futures contracts on other commodities whose prices are closely correlated to plastic prices. Futures on Commodity A have a correlation of 0.85 with the price of plastic, and futures on Commodity B have a correlation of 0.92 with the price of plastic. Futures on both Commodity A and Commodity B are available with 6-month and 9-month expirations. Ignoring liquidity considerations, which contract would be the best to minimize basis risk?

**a.** Futures on Commodity A with 6 months to expiration
**b.** Futures on Commodity A with 9 months to expiration
**c.** Futures on Commodity B with 6 months to expiration
**d.** Futures on Commodity B with 9 months to expiration

**6.** An analyst is examining the exchange rate between the U.S. dollar and the euro and is given the following information regarding the USD/EUR exchange rate and the respective domestic risk-free rates:

Current USD/EUR exchange rate is 1.25
Current USD-denominated 1-year risk-free interest rate is 4% per year
Current EUR-denominated 1-year risk-free interest rate is 7% per year

According to the interest rate parity theorem, what is the 1-year forward USD/EUR exchange rate?

**a.** 0.78
**b.** 0.82
**c.** 1.21
**d.** 1.29

**7.** An investor sells a January 2014 call on the stock of XYZ Limited with a strike price of USD 50 for USD 10, and buys a January 2014 call on the same underlying stock with a strike price of USD 60 for USD 2. What is the name of this strategy, and what is the maximum profit and loss the investor could incur at expiration?

| | *Strategy* | *Maximum Profit* | *Maximum Loss* |
|---|---|---|---|
| **a.** | Bear spread | USD 8 | USD 2 |
| **b.** | Bull spread | USD 8 | Unlimited |
| **c.** | Bear spread | Unlimited | USD 2 |
| **d.** | Bull spread | USD 8 | USD 2 |

**8.** An analyst is trying to get some insight into the relationship between the return on stock LMD ($R_{LMD,t}$) and the return on the S&P 500 index ($R_{S\&P,t}$). Using historical data, the analyst estimates the following:

| | |
|---|---|
| Annual mean return for LMD: | 11% |
| Annual mean return for S&P 500 index: | 7% |
| Annual volatility for S&P 500 index: | 18% |
| Covariance between the returns of LMD and S&P 500 index: | 6% |

Assuming the analyst uses the same data to estimate the regression model given by:

$R_{LMD,t} = \alpha + \beta R_{S\&P,t} + \varepsilon_t$

Using the ordinary least squares technique, which of the following models will the analyst obtain?

**a.** $R_{LMD,t} = -0.02 + 0.54R_{S\&P,t} + \varepsilon_t$
**b.** $R_{LMD,t} = -0.02 + 1.85R_{S\&P,t} + \varepsilon_t$
**c.** $R_{LMD,t} = 0.04 + 0.54R_{S\&P,t} + \varepsilon_t$
**d.** $R_{LMD,t} = 0.04 + 1.85R_{S\&P,t} + \varepsilon_t$

**9.** For a sample of 400 firms, the relationship between corporate revenue ($Y_i$) and the average years of experience per employee ($X_i$) is modeled as follows:

$Y_i = \beta_1 + \beta_2 X_i + \varepsilon_i, \quad i = 1, 2, ..., 400$

You wish to test the joint null hypothesis that $\beta_1 = 0$ and $\beta_2 = 0$ at the 95% confidence level. The p-value for the t-statistic for $\beta_1$ is 0.07, and the p-value for the t-statistic for $\beta_2$ is 0.06. The p-value for the F-statistic for the regression is 0.045. Which of the following statements is correct?

**a.** You can reject the null hypothesis because each β is different from 0 at the 95% confidence level.
**b.** You cannot reject the null hypothesis because neither β is different from 0 at the 95% confidence level.
**c.** You can reject the null hypothesis because the F-statistic is significant at the 95% confidence level.
**d.** You cannot reject the null hypothesis because the F-statistic is not significant at the 95% confidence level.

**10.** A fixed income portfolio manager currently holds a portfolio of bonds of various companies. Assuming all these bonds have the same annualized probability of default and that the defaults are independent, the number of defaults in this portfolio over the next year follows which type of distribution?

- **a.** Bernoulli
- **b.** Normal
- **c.** Binomial
- **d.** Exponential

**11.** An analyst has been asked to check for arbitrage opportunities in the Treasury bond market by comparing the cash flows of selected bonds with the cash flows of combinations of other bonds. If a 1-year zero-coupon bond is priced at USD 96.12 and a 1-year bond paying a 10% coupon semi-annually is priced at USD 106.20, what should be the price of a 1-year Treasury bond that pays a coupon of 8% semi-annually?

- **a.** USD 98.10
- **b.** USD 101.23
- **c.** USD 103.35
- **d.** USD 104.18

**12.** If the current market price of a stock is USD 50, which of the following options on the stock has the highest gamma?

- **a.** Call option expiring in 30 days with strike price of USD 50
- **b.** Call option expiring in 5 days with strike price of USD 30
- **c.** Call option expiring in 5 days with strike price of USD 50
- **d.** Put option expiring in 30 days with strike price of USD 30

**13.** An investment advisor is advising a wealthy client of the company. The client would like to invest USD 500,000 in a bond rated at least AA. The advisor is considering bonds issued by Company X, Company Y, and Company Z, and wants to choose a bond that satisfies the client's rating requirement, but also has the highest yield to maturity. The advisor has gathered the following information:

| | X | Y | Z |
|---|---|---|---|
| Bond Rating | AA+ | A+ | AAA |
| Semiannual Coupon | 1.75% | 1.78% | 1.69% |
| Term to Maturity in years | 5 | 5 | 5 |
| Price (USD) | 975 | 973 | 989 |
| Par value (USD) | 1000 | 1000 | 1000 |

Which bond should the investment advisor purchase for the client?

**a.** Y bond
**b.** X bond
**c.** Z bond
**d.** Either the Z bond or the Y bond

**14.** After evaluating the results of a firm's stress tests, an analyst is recommending that the firm allocate additional economic capital and purchase selective insurance protection to guard against particular events. In order to give management a fully informed assessment, it is important that the following is noted related to this strategy:

**a.** While decreasing liquidity risk exposure, it will likely increase market risk exposure.
**b.** While decreasing correlation risk exposure, it will likely increase credit risk exposure.
**c.** While decreasing market risk exposure, it will likely increase credit risk exposure.
**d.** While decreasing credit risk exposure, it will likely increase model risk exposure.

**15.** A portfolio manager bought 1,000 call options on a non-dividend-paying stock, with a strike price of USD 100, for USD 6 each. The current stock price is USD 104 with a daily stock return volatility of 1.89%, and the delta of the option is 0.6. Using the delta-normal approach to calculate VaR, what is an approximation of the 1-day 95% VaR of this position?

**a.** USD 112
**b.** USD 1,946
**c.** USD 3,243
**d.** USD 5,406

**16.** Which of the following statements concerning the measurement of operational risk is correct?

**a.** Economic capital should be sufficient to cover both expected and worst-case operational risk losses.
**b.** Loss severity and loss frequency tend to be modeled with lognormal distributions.
**c.** Operational loss data available from data vendors tend to be biased towards small losses.
**d.** The standardized approach used by banks in calculating operational risk capital allows for different beta factors to be assigned to different business lines.

**17.** The proper selection of factors to include in an ordinary least squares estimation is critical to the accuracy of the result. When does omitted variable bias occur?

**a.** Omitted variable bias occurs when the omitted variable is correlated with the included regressor and is a determinant of the dependent variable.
**b.** Omitted variable bias occurs when the omitted variable is correlated with the included regressor but is not a determinant of the dependent variable.
**c.** Omitted variable bias occurs when the omitted variable is independent of the included regressor and is a determinant of the dependent variable.
**d.** Omitted variable bias occurs when the omitted variable is independent of the included regressor but is not a determinant of the dependent variable.

**18.** Assume that an investor is only concerned with systematic risk. Which of the following would be the best measure to use to rank order funds with different betas based on their risk-return relationship with the market portfolio?

**a.** Treynor ratio
**b.** Sharpe ratio
**c.** Jensen's alpha
**d.** Sortino ratio

**19.** The collapse of Long Term Capital Management (LTCM) is a classic risk management case study. Which of the following statements about risk management at LTCM is correct?

**a.** LTCM had no active risk reporting.
**b.** At LTCM, stress testing became a risk management department exercise that had little influence on the firm's strategy.
**c.** LTCM's use of high leverage is evidence of poor risk management.
**d.** LTCM failed to account properly for the illiquidity of its largest positions in its risk calculations.

**20.** Which of the following is a potential consequence of violating the GARP Code of Conduct once a formal determination is made that such a violation has occurred?

- **a.** Formal notification to the GARP Member's employer of such a violation
- **b.** Suspension of the GARP Member's right to work in the risk management profession
- **c.** Removal of the GARP Member's right to use the FRM designation
- **d.** Required participation in ethical training

**21.** Which of the following is assumed in the multiple least squares regression model?

- **a.** The dependent variable is stationary.
- **b.** The independent variables are not perfectly multicollinear.
- **c.** The error terms are heteroskedastic.
- **d.** The independent variables are homoskedastic.

**22.** A bank's risk manager is considering different viewpoints for reporting data quality metrics within a data quality scorecard: a data quality issues viewpoint, a business process viewpoint, and a business impact viewpoint. For which of the following purposes would a business process viewpoint be most effective?

- **a.** Aggregating the business impacts of poor quality data across different business processes.
- **b.** Creating a high-level overview of risks associated with data issues on the trading desk.
- **c.** Isolating the point at which data issues begin to arise in a foreign exchange hedging procedure.
- **d.** Identifying organizational processes that require enhanced monitoring and control.

**23.** Suppose the S&P 500 has an expected annual return of 7.6% and volatility of 10.8%. Suppose the Atlantis Fund has an expected annual return of 8.3% and volatility of 8.8% and is benchmarked against the S&P 500. If the risk-free rate is 2.0% per year, what is the beta of the Atlantis Fund according to the Capital Asset Pricing Model?

- **a.** 0.81
- **b.** 0.89
- **c.** 1.13
- **d.** 1.23

**24.** In October 1994, General Electric sold Kidder Peabody to Paine Webber, which eventually dismantled the firm. Which of the following led up to the sale?

- **a.** Kidder Peabody had its primary dealer status revoked by the Federal Reserve after it was found to have submitted fraudulent bids at US Treasury auctions.
- **b.** Kidder Peabody reported a large quarterly loss from highly leveraged positions, which left the company insolvent and on the verge of bankruptcy.
- **c.** Kidder Peabody suffered a large loss when counterparties to its CDS portfolio could not honor their contracts, which left the company with little equity.
- **d.** Kidder Peabody reported a sudden large accounting loss to correct an error in the firm's accounting system, which called into question the management team's competence.

**25.** An analyst is evaluating the performance of a portfolio of Mexican equities that is benchmarked to the IPC Index. The analyst collects the information about the portfolio and the benchmark index shown in the table below:

| | |
|---|---|
| Expected return on the portfolio | 6.6% |
| Volatility of returns on the portfolio | 13.1% |
| Expected return on the IPC Index | 4.0% |
| Volatility of returns on the IPC Index | 8.7% |
| Risk-free rate of return | 1.5% |
| Beta of portfolio relative to IPC Index | 1.4 |

What is the Sharpe ratio for this portfolio?

- **a.** 0.036
- **b.** 0.047
- **c.** 0.389
- **d.** 0.504

**26.** A risk manager has estimated a regression of a firm's monthly portfolio returns against the returns of three U.S. domestic equity indexes: the Russell 1000 index, the Russell 2000 index, and the Russell 3000 index. The results are shown below.

| Regression Statistics | |
|---|---|
| Multiple R | 0.951 |
| R Square | 0.905 |
| Adjusted R Square | 0.903 |
| Standard Error | 0.009 |
| Observations | 192 |

| Regression Output | Coefficients | Standard Error | t-Stat | P-value |
|---|---|---|---|---|
| Intercept | 0.0023 | 0.0006 | 3.5305 | 0.0005 |
| Russell 1000 | 0.1093 | 1.5895 | 0.0688 | 0.9452 |
| Russell 2000 | 0.1055 | 0.1384 | 0.7621 | 0.4470 |
| Russell 3000 | 0.3533 | 1.7274 | 0.2045 | 0.8382 |

| Correlation Matrix | Portfolio Returns | Russell 1000 | Russell 2000 | Russell 3000 |
|---|---|---|---|---|
| Portfolio Returns | 1.000 | | | |
| Russell 1000 | 0.937 | 1.000 | | |
| Russell 2000 | 0.856 | 0.813 | 1.000 | |
| Russell 3000 | 0.945 | 0.998 | 0.845 | 1.000 |

Based on the regression results, which statement is correct?

**a.** The estimated coefficient of 0.3533 indicates that the returns of the Russell 3000 index are more statistically significant in determining the portfolio returns than the other two indexes.
**b.** The high adjusted $R^2$ indicates that the estimated coefficients on the Russell 1000, Russell 2000, and Russell 3000 indexes are statistically significant.
**c.** The high p-value of 0.9452 indicates that the regression coefficient of the returns of Russell 1000 is more statistically significant than the other two indexes.
**d.** The high correlations between each pair of index returns indicate that multicollinearity exists between the variables in this regression.

**27.** An analyst is examining a portfolio that consists of 600 subprime mortgages and 400 prime mortgages. Of the subprime mortgages, 120 are late on their payments. Of the prime mortgages, 40 are late on their payments. If the analyst randomly selects a mortgage from the portfolio and it is currently late on its payments, what is the probability that it is a subprime mortgage?

**a.** 60%
**b.** 67%
**c.** 75%
**d.** 80%

**28.** An analyst is testing a hypothesis that the beta, $\beta$, of stock CDM is 1. The analyst runs an ordinary least squares regression of the monthly returns of CDM, $R_{CDM}$, on the monthly returns of the S&P 500 index, $R_m$, and obtains the following relation:

$R_{CDM} = 0.86\, R_m - 0.32$

The analyst also observes that the standard error of the coefficient of $R_m$ is 0.80. In order to test the hypothesis H0: $\beta = 1$ against H1: $\beta \neq 1$, what is the correct statistic to calculate?

**a.** t-statistic
**b.** Chi-square test statistic
**c.** Jarque-Bera test statistic
**d.** Sum of squared residuals

**29.** Which of the following statements about the exponentially weighted moving average (EWMA) model and the generalized autoregressive conditional heteroscedasticity (GARCH(1,1)) model is correct?

**a.** The EWMA model is a special case of the GARCH(1,1) model with the additional assumption that the long-run volatility is zero.
**b.** A variance estimate from the EWMA model is always between the prior day's estimated variance and the prior day's squared return.
**c.** The GARCH(1,1) model always assigns less weight to the prior day's estimated variance than the EWMA model.
**d.** A variance estimate from the GARCH(1,1) model is always between the prior day's estimated variance and the prior day's squared return.

**30.** A risk manager is examining a Hong Kong trader's profit and loss record for the last week, as shown in the table below:

| Trading Day | Profit/Loss (HKD million) |
|---|---|
| Monday | 10 |
| Tuesday | 80 |
| Wednesday | 90 |
| Thursday | -60 |
| Friday | 30 |

The profits and losses are normally distributed with a mean of 4.5 million HKD and assume that transaction costs can be ignored. Part of the t-table is provided below:

Percentage Point of the t-Distribution

$P(T>t) = \alpha$

| | $\alpha$ | | |
|---|---|---|---|
| Degrees of Freedom | 0.3 | 0.2 | 0.15 |
| 4 | 0.569 | 0.941 | 1.19 |
| 5 | 0.559 | 0.92 | 1.16 |

According to the information provided above, what is the probability that this trader will record a profit of at least HKD 30 million on the first trading day of next week?

**a.** About 15%
**b.** About 20%
**c.** About 80%
**d.** About 85%

**31.** An experienced commodities risk manager is examining corn futures quotes from the CME Group. Which of the following observations would the risk manager most likely view as a potential problem with the quotation data?

**a.** The volume in a specific contract is greater than the open interest.
**b.** The prices indicate a mixture of normal and inverted markets.
**c.** The settlement price for a specific contract is above the high price.
**d.** There is no contract with maturity in a particular month.

**32.** A portfolio manager controls USD 88 million par value of zero-coupon bonds maturing in 5 years and yielding 4%. The portfolio manager expects that interest rates will increase. To hedge the exposure, the portfolio manager wants to sell part of the 5-year bond position and use the proceeds from the sale to purchase zero-coupon bonds maturing in 1.5 years and yielding 3%. What is the market value of the 1.5-year bonds that the portfolio manager should purchase to reduce the duration on the combined position to 3 years?

**a.** USD 41.17 million
**b.** USD 43.06 million
**c.** USD 43.28 million
**d.** USD 50.28 million

**33.** A 15-month futures contract on an equity index is currently trading at USD 3,767.52. The underlying index is currently valued at USD 3,625 and has a continuously-compounded dividend yield of 2% per year. The continuously compounded risk-free rate is 5% per year. Assuming no transactions costs, what is the potential arbitrage profit per contract and the appropriate strategy?

**a.** USD 189, buy the futures contract and sell the underlying.
**b.** USD 4, buy the futures contract and sell the underlying.
**c.** USD 189, sell the futures contract and buy the underlying.
**d.** USD 4, sell the futures contract and buy the underlying.

**34.** Savers Bancorp entered into a swap agreement over a 2-year period on August 9, 2008, with which it received a 4.00% fixed rate and paid LIBOR plus 1.20% on a notional amount of USD 6.5 million. Payments were to be made every 6 months. The table below displays the actual annual 6-month LIBOR rates over the 2-year period.

| Date | 6-month LIBOR |
|---|---|
| Aug 9, 2008 | 3.11% |
| Feb 9, 2009 | 1.76% |
| Aug 9, 2009 | 0.84% |
| Feb 9, 2010 | 0.39% |
| Aug 9, 2010 | 0.58% |

Assuming no default, how much did Savers Bancorp receive on August 9, 2010?

**a.** USD 72,150
**b.** USD 78,325
**c.** USD 117,325
**d.** USD 156,650

**35.** The six-month forward price of commodity X is USD 1,000. Six-month, risk-free, zero-coupon bonds with face value USD 1,000 trade in the fixed income market. When taken in the correct amounts, which of the following strategies creates a synthetic long position in commodity X for a period of 6 months?

**a.** Short the forward contract and short the zero-coupon bond.
**b.** Short the forward contract and buy the zero-coupon bond.
**c.** Buy the forward contract and short the zero-coupon bond.
**d.** Buy the forward contract and buy the zero-coupon bond.

**36.** Bank A and Bank B are two competing investment banks that are calculating the 1-day 99% VaR for an at-the-money call on a non-dividend-paying stock with the following information:

- Current stock price: USD 120
- Estimated annual stock return volatility: 18%
- Current Black-Scholes-Merton option value: USD 5.20
- Option delta: 0.6

To compute VaR, Bank A uses the linear approximation method, while Bank B uses a Monte Carlo simulation method for full revaluation. Which bank will estimate a higher value for the 1-day 99% VaR?

**a.** Bank A.
**b.** Bank B.
**c.** Both will have the same VaR estimate.
**d.** Insufficient information to determine.

**37.** In evaluating the dynamic delta hedging of a portfolio of short option positions, which of the following is correct?

**a.** The interest cost of carrying the delta hedge will be highest when the options are deep out-of-the-money.
**b.** The interest cost of carrying the delta hedge will be highest when the options are deep in-the-money.
**c.** The interest cost of carrying the delta hedge will be lowest when the options are at-the-money.
**d.** The interest cost of carrying the delta hedge will be highest when the options are at-the-money.

**QUESTIONS 38 AND 39 REFER TO THE FOLLOWING INFORMATION**

A risk manager is evaluating the price sensitivity of an investment-grade callable bond using the firm's valuation system. The table below presents information on the bond as well as on the embedded option. The current interest rate environment is flat at 5%.

Value in USD per USD 100 face value

| Interest Rate Level | Callable Bond | Call Option |
|---|---|---|
| 4.98% | 102.07848 | 2.08719 |
| 5.00% | 101.61158 | 2.05010 |
| 5.02% | 100.92189 | 2.01319 |

**38.** The DV01 of a comparable bond with no embedded options having the same maturity and coupon rate is closest to:

**a.** 0.0185
**b.** 0.2706
**c.** 0.2891
**d.** 0.3077

SEE INFORMATION PRECEDING QUESTION 39

A risk manager is evaluating the price sensitivity of an investment-grade callable bond using the firm's valuation system. The table below presents information on the bond as well as on the embedded option. The current interest rate environment is flat at 5%.

| Value in USD per USD 100 face value | | |
|---|---|---|
| Interest Rate Level | Callable Bond | Call Option |
| 4.98% | 102.07848 | 2.08719 |
| 5.00% | 101.61158 | 2.05010 |
| 5.02% | 100.92189 | 2.01319 |

**39.** The convexity of the callable bond can be estimated as:

- **a.** -55,698
- **b.** -54,814
- **c.** -5.5698
- **d.** -5.4814

**40.** A portfolio contains a long position in an option contract on a US Treasury bond. The option exhibits positive convexity across the entire range of potential returns for the underlying bond. This positive convexity:

- **a.** Implies that the option's value increases at a decreasing rate as the option goes further into the money.
- **b.** Makes a long option position a superior investment compared to a long bond position of equivalent duration.
- **c.** Can be effectively hedged by the sale of a negatively convex financial instrument.
- **d.** Implies that the option increases in value as market volatility increases.

**41.** An implementation principle recommended by the Basel Committee to banks for the governance of sound stress testing practices is that stress testing reports should:

- **a.** Not be passed up to senior management without first being approved by middle management.
- **b.** Have limited input from their respective business areas to prevent biasing of the results.
- **c.** Challenge prior assumptions to help foster debate among decision makers.
- **d.** Be separated by business lines to help identify risk concentrations.

**42.** A risk manager performs an ordinary least squares (OLS) regression to estimate the sensitivity of a stock's return to the return on the S&P 500. This OLS procedure is designed to:

**a.** Minimize the square of the sum of differences between the actual and estimated S&P 500 returns.
**b.** Minimize the square of the sum of differences between the actual and estimated stock returns.
**c.** Minimize the sum of differences between the actual and estimated squared S&P 500 returns.
**d.** Minimize the sum of squared differences between the actual and estimated stock returns.

**43.** Using the prior 12 monthly returns, an analyst estimates the mean monthly return of stock XYZ to be -0.75% with a standard error of 2.70%.

| ONE-TAILED T-DISTRIBUTION TABLE | | | |
|---|---|---|---|
| Degrees of Freedom | | α | |
| | 0.10 | 0.05 | 0.025 |
| 8 | 1.397 | 1.860 | 2.306 |
| 9 | 1.383 | 1.833 | 2.262 |
| 10 | 1.372 | 1.812 | 2.228 |
| 11 | 1.363 | 1.796 | 2.201 |
| 12 | 1.356 | 1.782 | 2.179 |

Using the t-table above, the 95% confidence interval for the mean return is between:

**a.** -6.69% and 5.19%
**b.** -6.63% and 5.15%
**c.** -5.60% and 4.10%
**d.** -5.56% and 4.06%

**44.** Using data from a pool of mortgage borrowers, a credit risk analyst performed an ordinary least squares regression of annual savings (in GBP) against annual household income (in GBP) and obtained the following relationship:

Annual Savings = 0.24 * Household Income - 25.66, $R^2 = 0.50$

Assuming that all coefficients are statistically significant, which interpretation of this result is correct?

**a.** For this sample data, the average error term is GBP -25.66.
**b.** For a household with no income, annual savings is GBP 0.
**c.** For an increase of GBP 1,000 in income, expected annual savings will increase by GBP 240.
**d.** For a decrease of GBP 2,000 in income, expected annual savings will increase by GBP 480.

**45.** A risk analyst is estimating the variance of stock returns on day n, given by $\sigma_n^2$, using the equation $\sigma_n^2 = \gamma V_L + \alpha u_{n-1}^2 + \beta\sigma_{n-1}^2$ where $u_{n-1}$ and $\sigma_{n-1}$ represent the return and volatility on day n-1, respectively. If the values of α and β are as indicated below, which combination of values indicates that the variance follows a stable GARCH (1,1) process?

**a.** α = 0.084427 and β = 0.909073
**b.** α = 0.084427 and β = 0.925573
**c.** α = 0.085427 and β = 0.925573
**d.** α = 0.090927 and β = 0.925573

**The following information applies to questions 46 and 47**

A portfolio manager holds three bonds in one of the portfolios and each bond has a 1-year default probability of 15%. The event of default for each of the bonds is independent.

**46.** What is the probability of exactly two bonds defaulting over the next year?

**a.** 1.9%
**b.** 5.7%
**c.** 10.8%
**d.** 32.5%

**47.** What is the mean and variance of the number of bonds defaulting over the next year?

**a.** Mean = 0.15, variance = 0.32
**b.** Mean = 0.45, variance = 0.38
**c.** Mean = 0.45, variance = 0.32
**d.** Mean = 0.15, variance = 0.38

**48.** An investment advisor is analyzing the range of potential expected returns of a new fund designed to replicate the directional moves of the BSE Sensex Index but with twice the volatility of the index. The Sensex has an expected annual return of 12.3% and volatility of 19.0%, and the risk free rate is 2.5% per year. Assuming the correlation between the fund's returns and that of the index is 1, what is the expected return of the fund using the capital asset pricing model?

**a.** 18.5%
**b.** 19.0%
**c.** 22.1%
**d.** 24.6%

**49.** A risk analyst is reconciling customer account data held in two separate databases and wants to ensure the account number for each customer is the same in each database. Which dimension of data quality would she be most concerned with in making this comparison?

- **a.** Completeness
- **b.** Accuracy
- **c.** Consistency
- **d.** Currency

**50.** The hybrid approach for estimating VaR is the combination of a parametric and a nonparametric approach. It specifically combines the historical simulation approach with:

- **a.** The delta normal approach.
- **b.** The exponentially weighted moving average approach.
- **c.** The multivariate density estimation approach.
- **d.** The generalized autoregressive conditional heteroskedasticity approach.

**51.** A non-dividend-paying stock is currently trading at USD 40 and has an expected return of 12% per year. Using the Black-Scholes-Merton (BSM) model, a 1-year, European-style call option on the stock is valued at USD 1.78. The parameters used in the model are:

$N(d_1) = 0.29123$ $N(d_2) = 0.20333$

The next day, the company announces that it will pay a dividend of USD 0.5 per share to holders of the stock on an ex-dividend date 1 month from now and has no further dividend payout plans for at least 1 year. This new information does not affect the current stock price, but the BSM model inputs change, so that:

$N(d_1) = 0.29928$ $N(d_2) = 0.20333$

If the risk-free rate is 3% per year, what is the new BSM call price?

- **a.** USD 1.61
- **b.** USD 1.78
- **c.** USD 1.95
- **d.** USD 2.11

**52.** An at-the-money European call option on the DJ EURO STOXX 50 index with a strike of 2200 and maturing in 1 year is trading at EUR 350, where contract value is determined by EUR 10 per index point. The risk-free rate is 3% per year, and the daily volatility of the index is 2.05%. If we assume that the expected return on the DJ EURO STOXX 50 is 0%, the 99% 1-day VaR of a short position on a single call option calculated using the delta-normal approach is closest to:

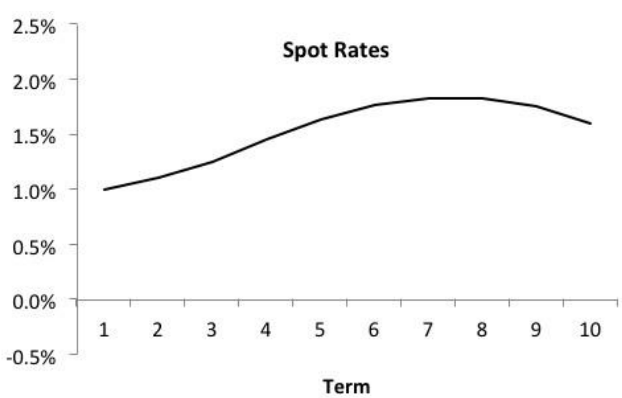
**a.** EUR 8.
**b.** EUR 53.
**c.** EUR 84.
**d.** EUR 525.

**53.** The current stock price of a company is USD 80. A risk manager is monitoring call and put options on the stock with exercise prices of USD 50 and 5 days to maturity. Which of these scenarios is most likely to occur if the stock price falls by USD 1?

| Scenario | Call Value | Put Value |
|---|---|---|
| A | Decrease by USD 0.94 | Increase by USD 0.08 |
| B | Decrease by USD 0.94 | Increase by USD 0.89 |
| C | Decrease by USD 0.07 | Increase by USD 0.89 |
| D | Decrease by USD 0.07 | Increase by USD 0.08 |

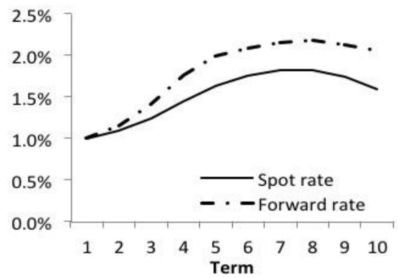
**a.** Scenario A
**b.** Scenario B
**c.** Scenario C
**d.** Scenario D

**54.** Below is a chart showing the term structure of risk-free spot rates:

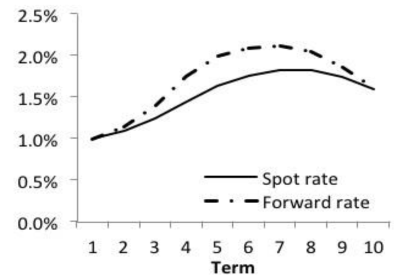


Which of the following charts presents the correct derived forward rate curve?

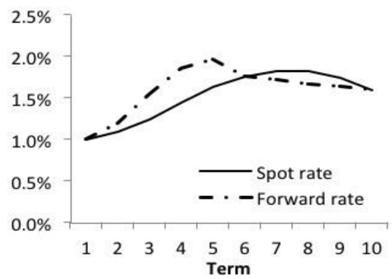
**a.**



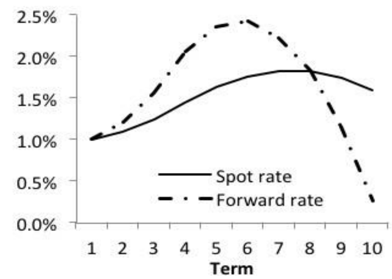

**b.**




**c.**




**d.**




**55.** A hedge fund manager wants to change the fund's interest rate exposure by investing in fixed-income securities with negative duration. Which of the following securities should the fund manager buy?

- **a.** Short maturity calls on zero-coupon bonds with long maturity
- **b.** Short maturity puts on interest-only strips from long maturity conforming mortgages
- **c.** Short maturity puts on zero-coupon bonds with long maturity
- **d.** Short maturity calls on principal-only strips from long maturity conforming mortgages

**56.** A trader writes the following 1-year European-style barrier options as protection against large movements in a non-dividend paying stock that is currently trading at EUR 40.96.

| Option | Price (EUR) |
|---|---|
| Up-and-in barrier call, with barrier at EUR 45 | 3.52 |
| Up-and-out barrier call, with barrier at EUR 45 | 1.24 |
| Down-and-in barrier put, with barrier at EUR 35 | 2.00 |
| Down-and-out barrier put, with barrier at EUR 35 | 1.01 |

All of the options have the same strike price. Assuming the risk-free rate is 2% per annum, what is the common strike price of these options?

**a.** EUR 39.00
**b.** EUR 40.00
**c.** EUR 41.00
**d.** EUR 42.00

**57.** A fixed-income portfolio manager purchases a seasoned 5.5% agency mortgage-backed security with a weighted average loan age of 60 months. The current balance on the loans is USD 20 million, and the conditional prepayment rate is assumed to be constant at 0.4% per year. Which of the following is closest to the expected principal prepayment this month?

**a.** USD 1,000
**b.** USD 7,000
**c.** USD 10,000
**d.** USD 70,000

**58.** The rating agencies have analyzed the creditworthiness of Company XYZ and have determined that the company currently has adequate payment capacity, although a negative change in the business environment could affect its capacity for repayment. The company has been given an investment grade rating by S&P and Moody's. Which of the following S&P/Moody's ratings has Company XYZ been assigned?

**a.** AA/Aa
**b.** A/A
**c.** BBB/Baa
**d.** BB/Ba

**59.** A French bank enters into a 6-month forward contract with an importer to sell GBP 40 million in 6 months at a rate of EUR 0.80 per GBP. If in 6 months the exchange rate is EUR 0.85 per GBP, what is the payoff for the bank from the forward contract?

- **a.** EUR -2,941,176
- **b.** EUR -2,000,000
- **c.** EUR 2,000,000
- **d.** EUR 2,941,176

**60.** An oil driller recently issued USD 250 million of fixed-rate debt at 4.0% per annum to help fund a new project. It now wants to convert this debt to a floating-rate obligation using a swap. A swap desk analyst for a large investment bank that is a market maker in swaps has identified four firms interested in swapping their debt from floating-rate to fixed-rate. The following table quotes available loan rates for the oil driller and each firm:

| Firm | Fixed-rate (in %) | Floating-rate (in %) |
|---|---|---|
| Oil driller | 4.0 | 6-month LIBOR + 1.5 |
| Firm A | 3.5 | 6-month LIBOR + 1.0 |
| Firm B | 6.0 | 6-month LIBOR + 3.0 |
| Firm C | 5.5 | 6-month LIBOR + 2.0 |
| Firm D | 4.5 | 6-month LIBOR + 2.5 |

A swap between the oil driller and which firm offers the greatest possible combined benefit?

- **a.** Firm A
- **b.** Firm B
- **c.** Firm C
- **d.** Firm D

**61.** Consider an American call option and an American put option, each with 3 months to maturity, written on a non-dividend-paying stock currently priced at USD 40. The strike price for both options is USD 35 and the risk-free rate is 1.5%. What are the lower and upper bounds on the difference between the prices of the call and put options?

| Scenario | Lower Bound (USD) | Upper Bound (USD) |
|---|---|---|
| A | 5.13 | 40.00 |
| B | 5.00 | 5.13 |
| C | 34.87 | 40.00 |
| D | 0.13 | 34.87 |

**a.** Scenario A
**b.** Scenario B
**c.** Scenario C
**d.** Scenario D

**62.** A German housing corporation needs to hedge against rising interest rates. It has chosen to use futures on 10-year German government bonds. Which position in the futures should the corporation take, and why?

**a.** Take a long position in the futures because rising interest rates lead to rising futures prices.
**b.** Take a short position in the futures because rising interest rates lead to rising futures prices.
**c.** Take a short position in the futures because rising interest rates lead to declining futures prices.
**d.** Take a long position in the futures because rising interest rates lead to declining futures prices.

**63.** Barings was forced to declare bankruptcy after reporting over USD 1 billion in unauthorized trading losses by a single trader, Nick Leeson. Which of the following statements concerning the collapse of Barings is correct?

**a.** Leeson avoided reporting the unauthorized trades by convincing the head of his back office that they did not need to be reported.
**b.** Management failed to investigate high levels of reported profits even though they were associated with a low-risk trading strategy.
**c.** Leeson traded primarily in OTC foreign currency swaps which allowed Barings to delay cash payments on losing trades until the first payment was due.
**d.** The loss at Barings was detected when several customers complained of losses on trades that were booked to their accounts.

**64.** For a sample of the past 30 monthly stock returns for McCreary, Inc., the mean return is 4% and the sample standard deviation is 20%. Since the population variance is unknown, the standard error of the sample is estimated to be:

$$S_x = \frac{20\%}{\sqrt{30}} = 3.65\%$$

The related t-table values are ($t_{i,j}$ denotes the (100-$j$)th percentile of $t$-distribution value with $i$ degrees of freedom):

| | |
|---|---|
| $t_{29,2.5}$ | 2.045 |
| $t_{29,5.0}$ | 1.699 |
| $t_{30,2.5}$ | 2.042 |
| $t_{30,5.0}$ | 1.697 |

What is the 95% confidence interval for the mean monthly return?

**a.** [-3.453%, 11.453%]
**b.** [-2.201%, 10.201%]
**c.** [-2.194%, 10.194%]
**d.** [-3.467%, 11.467%]

**65.** Suppose that a quiz consists of 20 true-false questions. A student has not studied for the exam and just randomly guesses the answers. How would you find the probability that the student will get 8 or fewer answers correct?

**a.** Find the probability that X = 8 in a binomial distribution with n = 20 and p = 0.5.
**b.** Find the area between 0 and 8 in a uniform distribution that goes from 0 to 20.
**c.** Find the probability that X = 8 for a normal distribution with mean of 10 and standard deviation of 5.
**d.** Find the cumulative probability for 8 in a binomial distribution with n = 20 and p = 0.5.

**66.** Assume that a random variable follows a normal distribution with a mean of 80 and a standard deviation of 24. What percentage of this distribution is not between 32 and 116?

**a.** 4.56%
**b.** 8.96%
**c.** 13.36%
**d.** 18.15%

**67.** An insurance company estimates that 40% of policyholders who have only an auto policy will renew next year, and 60% of policyholders who have only a homeowner policy will renew next year. The company estimates that 80% of policyholders who have both an auto and a homeowner policy will renew at least one of those policies next year. Company records show that 65% of policyholders have an auto policy, 50% of policyholders have a homeowner policy, and 15% of policyholders have both an auto and a homeowner policy. Using the company's estimates, what is the percentage of policyholders that will renew at least one policy next year?

**a.** 20%
**b.** 29%
**c.** 41%
**d.** 53%

**68.** A risk manager is calculating the VaR of a fund with a data set of 25 weekly returns. The mean and standard deviation of weekly returns are 7% and 10%, respectively. Assuming that weekly returns are independent and identically distributed, what is the standard deviation of the mean of the weekly returns?

**a.** 0.4%
**b.** 0.7%
**c.** 2.0%
**d.** 10.0%

**69.** The recent performance of Prudent Fund, with USD 50 million in assets, has been weak and the institutional sales group is recommending that it be merged with Aggressive Fund, a USD 200 million fund. The returns on Prudent Fund are normally distributed with a mean of 3% and a standard deviation of 7% and the returns on Aggressive Fund are normally distributed with a mean of 7% and a standard deviation of 15%. Senior management has asked an analyst to estimate the likelihood that returns on the combined portfolio will exceed 26%. Assuming the returns on the two funds are independent, the analyst's estimate for the probability that the returns on the combined fund will exceed 26% is closest to:

**a.** 1.0%
**b.** 2.5%
**c.** 5.0%
**d.** 10.0%

**70.** Which of the following four statements on models for estimating volatility is INCORRECT?

- **a.** In the exponentially weighted moving average (EWMA) model, some positive weight is assigned to the long-run average variance.
- **b.** In the EWMA model, the weights assigned to observations decrease exponentially as the observations become older.
- **c.** In the GARCH (1, 1) model, a positive weight is estimated for the long-run average variance.
- **d.** In the GARCH (1, 1) model, the weights estimated for observations decrease exponentially as the observations become older.

**71.** A stock index is valued at USD 750 and pays a continuous dividend at the rate of 2% per annum. The 6-month futures contract on that index is trading at USD 757. The risk-free rate is 3.50% continuously compounded. Assuming no transaction costs or taxes, which of the following numbers comes closest to the arbitrage profit that can be realized by taking a position in one futures contract?

- **a.** 4.18
- **b.** 1.35
- **c.** 12.60
- **d.** There is no arbitrage opportunity.

**72.** On Nov. 1, a fund manager of a USD 60 million U.S. medium-to-large cap equity portfolio, considers locking up the profit from the recent rally. The S&P 500 index and its futures with the multiplier of 250 are trading at 900 and 910, respectively. Instead of selling off the holdings, the fund manager would rather hedge two-thirds of his market exposure over the remaining two months. Given that the correlation between the portfolio and the S&P 500 index futures is 0.89 and the volatilities of the equity fund and the futures are 0.51 and 0.48 per year, respectively, what position should the manager take to achieve the objective?

- **a.** Sell 250 futures contracts of S&P 500
- **b.** Sell 169 futures contracts of S&P 500
- **c.** Sell 167 futures contracts of S&P 500
- **d.** Sell 148 futures contracts of S&P 500

**73.** The following statement is made by S&P about the creditworthiness of company XYZ: "Strong capacity to meet financial commitments, but somewhat susceptible to adverse economic conditions and changes in circumstances." What is the rating assigned by S&P to company XYZ?

- **a.** AAA
- **b.** A
- **c.** B
- **d.** C

**74.** Company XYZ operates in the U.S. On April 1, 2009, it has a net trade receivable of EUR 5,000,000 from an export contract to Germany. The company expects to receive this amount on Oct. 1, 2009. The CFO of XYZ wants to protect the value of this receivable. On April 1, 2009, the EUR spot rate is 1.34, and the 6-month EUR forward rate is 1.33. The CFO can lock in an exchange rate by taking a position in the forward contract. Alternatively, he can sell a 6-month EUR 5,000,000 call option with strike price of 1.34. The CFO thinks that selling an option is better than taking a forward position because if the EUR goes up, XYZ can take delivery of the USD at 1.34, which is better than the outright forward rate of 1.33.

If the EUR goes down, the contract will not be exercised. So, XYZ will pocket the premium obtained from selling the call option. What can be concluded about the CFO's analysis?

**a.** The CFO's analysis is correct. The company is better off whichever way the EUR rate goes.
**b.** The CFO's analysis is not correct. The company will suffer if the EUR goes up sharply.
**c.** The CFO's analysis is not correct. The company will suffer if the EUR moves within a narrow range.
**d.** The CFO's analysis is not correct. The company will suffer if the EUR goes down sharply.

**75.** An investor with a long position in a futures contract wants to issue instructions to close out the position. A market-if-touched order would be used if the investor wants to:

**a.** Execute at the best available price once a trade occurs at the specified or better price.
**b.** Execute at the best available price once a bid/offer occurs at the specified or worse price.
**c.** Allow a broker to delay execution of the order to get a better price.
**d.** Execute the order immediately or not at all.

**76.** Below is a table of term structure of swap rates:

| Maturity in Years | Swap Rate |
|---|---|
| 1 | 2.50% |
| 2 | 3.00% |
| 3 | 3.50% |
| 4 | 4.00% |
| 5 | 4.50% |

The 2-year forward swap rate starting in three years is closest to:

**a.** 3.50%
**b.** 4.50%
**c.** 5.51%
**d.** 6.02%

**77.** Three months ago, a company entered in a one-year forward contract to buy 100 ounces of gold. At the time, the one-year forward price was USD 1,000 per ounce. The nine-month forward price of gold is now USD 1,050 per ounce. The continuously-compounded risk-free rate is 4% per year for all maturities, and there are no storage costs. Which of the following is closest to the value of the contract?

- **a.** USD 1,897
- **b.** USD 4,852
- **c.** USD 5,000
- **d.** USD 7,955

**78.** Calculate the impact of a 10 basis point increase in yield on the following bond portfolio:

| Bond | Value (USD) | Modified Duration |
|---|---|---|
| 1 | 4,000,000 | 7.5 |
| 2 | 2,000,000 | 1.6 |
| 3 | 3,000,000 | 6.0 |
| 4 | 1,000,000 | 1.3 |

- **a.** USD -525,000
- **b.** USD -410,000
- **c.** USD -52,500
- **d.** USD -41,000

**79.** An oil producer has an obligation under an agreement to supply one million barrels of oil at a fixed price. The producer wishes to hedge this liability using futures in order to address the possibility of an upward movement in oil prices. In comparing a strip hedge to a stack and roll hedge, which of the following statements is correct?

- **a.** A stack and roll hedge tends to involve fewer transactions.
- **b.** A strip hedge tends to have smaller bid-ask spreads.
- **c.** A stack and roll hedge tends to have greater liquidity.
- **d.** A strip hedge tends to realize gains and losses more frequently.

**80.** A risk manager wishes to hedge an investment in zirconium using futures. Unfortunately, there are no futures that are based on this asset. To determine the best futures contract to hedge with, the risk manager runs a regression of daily changes in the price of zirconium against daily changes in the prices of similar assets that have futures contracts associated with them. Based on the results, futures tied to which asset would likely introduce the least basis risk into your hedging position?

| **Change in Price of Zirconium = α + β (Change in Price of Asset)** | | | |
|---|---|---|---|
| **Asset** | **α** | **β** | $R^2$ |
| A | 1.25 | 1.03 | 0.62 |
| B | 0.67 | 1.57 | 0.81 |
| C | 0.01 | 0.86 | 0.35 |
| D | 4.56 | 2.30 | 0.45 |

**a.** Asset A
**b.** Asset B
**c.** Asset C
**d.** Asset D

**81.** A homeowner has a 30-year, 5% fixed-rate mortgage with a current balance of USD 250,000. Mortgage rates have been decreasing. If the existing mortgage was refinanced into a new 30-years, 4% fixed rate mortgage, which of the following is closest to the amount that the homeowner would save in monthly mortgage payments?

**a.** USD 145
**b.** USD 150
**c.** USD 155
**d.** USD 160

**82.** The current stock price of a share is USD 100, and the continuously compounding risk-free rate is 12% per year. If the strike price for all options is USD 90, what are the maximum possible prices for a 3-month European call option, American call option, European put option, and American put option?

**a.** 97.04, 97.04, 87.34, 87.34
**b.** 97.04, 100, 90, 90
**c.** 100, 100, 87.34, 90
**d.** 100, 100, 90, 90

**83.** An analyst has been asked to estimate the VaR of an investment in Big Pharma Inc. The company's stock is trading at USD 23, and the stock has a daily volatility of 1.5%. Using the delta-normal method, the VaR at the 95% confidence level of a long position in an at-the-money put on this stock with a delta of -0.5 over a 1-day holding period is closest to which of the following choices?

**a.** USD 0.28
**b.** USD 0.40
**c.** USD 0.57
**d.** USD 2.84

**84.** Assume that portfolio daily returns are independently and identically normally distributed. A new quantitative analyst has been asked by the portfolio manager to calculate portfolio VaRs for 10-, 15-, 20-, and 25-day periods. The portfolio manager notices something amiss with the analyst's calculations displayed below. Which one of following VaRs on this portfolio is inconsistent with the others?

**a.** VaR(10-day) = USD 316M
**b.** VaR(15-day) = USD 465M
**c.** VaR(20-day) = USD 537M
**d.** VaR(25-day) = USD 600M

**85.** A portfolio manager uses a valuation model to estimate the value of a bond portfolio at USD 125.482 million. The term structure is flat. Using the same model, the portfolio manager estimates that the value of the portfolio would increase to USD 127.723 million if all interest rates fell by 30 basis points and would decrease to USD 122.164 million if all interest rates rose by 30 basis points. Using these estimates, the effective duration of the bond portfolio is closest to:

**a.** 7.38
**b.** 8.38
**c.** 14.77
**d.** 16.76

**86.** A trading portfolio consists of two bonds, A and B. Both have modified duration of three years and face value of USD 1,000. A is a zero-coupon bond, and its current price is USD 900. Bond B pays annual coupons and is priced at par. What is expected to happen to the market prices of A and B if the risk-free yield curve moves up by one basis point?

**a.** Both bond prices will move up by roughly the same amount.
**b.** Both bond prices will move up, but bond B will gain more than bond A.
**c.** Both bond prices will move down by roughly equal amounts.
**d.** Both bond prices will move down, but bond B will lose more than bond A.

**Common text for questions 87 and 88:**

A risk manager for Bank XYZ is considering writing a 6-month American put option on a non-dividend paying stock ABC. The current stock price is USD 50, and the strike price of the option is USD 52. In order to find the no-arbitrage price of the option, the manager uses a two-step binomial tree model. The stock price can go up or down by 20% each period. The manager's view is that the stock price has an 80% probability of going up each period and a 20% probability of going down. The annual risk-free rate is 12% with continuous compounding.

**87.** What is the risk-neutral probability of the stock price going up in a single step?

- **a.** 34.5%
- **b.** 57.6%
- **c.** 65.5%
- **d.** 80.0%

**88.** The no-arbitrage price of the option is closest to:

- **a.** USD 2.00
- **b.** USD 2.93
- **c.** USD 5.22
- **d.** USD 5.86

**89.** Which of the following statements is correct about the early exercise of American options?

- **a.** It is always optimal to exercise an American call option on a non-dividend-paying stock before the expiration date.
- **b.** It can be optimal to exercise an American put option on a non-dividend-paying stock early.
- **c.** It can be optimal to exercise an American call option on a non-dividend-paying stock early.
- **d.** It is never optimal to exercise an American put option on a non-dividend-paying stock before the expiration date.

**90.** A manager is responsible for the options desk in a London bank and is concerned about the impact of dividends on the options held by the options desk. The manager asks an analyst to assess which options are the most sensitive to dividend payments. What would be the analyst's answer if the value of the options is found by using the Black-Scholes model adjusted for dividends?

**a.** Everything else equal, out-of-the-money call options experience a larger decrease in value than in-the-money call options as expected dividends increase.
**b.** The increase in the value of in-the-money put options caused by an increase in expected dividends is always larger than the decrease in value of in-the-money call options.
**c.** Keeping the type of option constant, in-the-money options experience the greatest absolute change in value and out-of-the-money options the smallest absolute change in value as expected dividends increase.
**d.** Keeping the type of option constant, at-the-money options experience the largest absolute change in value and out-of-the-money options the smallest absolute change in value as a result of dividend payment.

**91.** A portfolio of investment securities for a regional bank has a current market value equal to USD 6,247,000 with a daily variance of 0.0002. Assuming there are 250 trading days in a year and that the portfolio returns follow a normal distribution, the estimate of the annual VaR at the 95% confidence level is closest to which of the following?

**a.** USD 32,595
**b.** USD 145,770
**c.** USD 2,297,507
**d.** USD 2,737,868

**92.** You are using key rate shifts to analyze the effect of yield changes on bond prices. Suppose that the 10-year yield has increased by ten basis points and that this shock decreases linearly to zero for the 20-year yield. What is the effect of this shock on the 14-year yield?

**a.** increase of zero basis points
**b.** increase of four basis points
**c.** increase of six basis points
**d.** increase of ten basis points

**93.** The efficient frontier is defined by the set of portfolios that, for each volatility level, maximizes the expected return. According to the capital asset pricing model (CAPM), which of the following statements is correct with respect to the efficient frontier?

- **a.** The capital market line always has a positive slope and its steepness depends on the market risk premium and the volatility of the market portfolio.
- **b.** The capital market line is the straight line connecting the risk-free asset with the zero beta minimum variance portfolio.
- **c.** Investors with the lowest risk aversion will typically hold the portfolio of risky assets that has the lowest standard deviation on the efficient frontier.
- **d.** The efficient frontier allows different individuals to have different portfolios of risky assets based upon their individual forecasts for asset returns.

**94.** Suppose that the correlation of the return of a portfolio with the return of its benchmark is 0.8, the volatility of the return of the portfolio is 5%, and the volatility of the return of the benchmark is 4%. What is the beta of the portfolio?

- **a.** 1.00
- **b.** 0.64
- **c.** 0.80
- **d.** -1.00

**95.** In characterizing various dimensions of a bank's data, the Basel Committee has suggested several principles to promote strong and effective risk data aggregation capabilities. Which statement correctly describes a recommendation that the bank should follow in accordance with the given principle?

- **a.** The integrity principle recommends that data aggregation should be completely automated without any manual intervention.
- **b.** The completeness principle recommends that a financial institution should capture data on its entire universe of material risk exposures.
- **c.** The adaptability principle recommends that a bank should frequently update its risk reporting systems to incorporate changes in best practices.
- **d.** The accuracy principle recommends that the risk data be reconciled with management's estimates of risk exposure prior to aggregation.

**96.** Which of the following is not necessarily considered a failure of risk management?

**a.** Incorrect measurement of known risks
**b.** Failure in communicating risk issues to top management
**c.** Failure to minimize losses on credit portfolios
**d.** Failure to use appropriate risk metrics

**97.** Portfolio A has an expected return of 8%, volatility of 20%, and beta of 0.5. Assume that the market has an expected return of 10% and volatility of 25%. Also, assume a risk-free rate of 5%. What is Jensen's alpha for portfolio A?

**a.** 0.5%
**b.** 1.0%
**c.** 10%
**d.** 15%

**98.** According to the Capital Asset Pricing Model (CAPM), over a single time period, investors seek to maximize their:

**a.** Wealth and are concerned about the tails of return distributions.
**b.** Wealth and are not concerned about the tails of return distributions.
**c.** Expected utility and are concerned about the tails of return distributions.
**d.** Expected utility and are not concerned about the tails of return distributions.

**99.** An analyst is analyzing the historical performance of two commodity funds tracking the Reuters/Jefferies-CRB® Index (CRB) as benchmark. The analyst collated the data on the monthly returns and decided to use the information ratio (IR) to assess which fund achieved higher returns more efficiently and presented his findings.

| | **Fund I** | **Fund II** | **Benchmark Returns** |
|---|---|---|---|
| Average monthly return | 1.4888% | 1.468% | 1.415% |
| Average excess return | 0.073% | 0.053% | 0.000% |
| Standard deviation of returns | 0.294% | 0.237% | 0.238% |
| Tracking error | 0.344% | 0.341% | 0,000% |

What is the information ratio for each fund, and what conclusion can be drawn?

**a.** IR for Fund I = 0.212, IR for Fund II = 0.155; Fund II performed better as it has a lower IR.
**b.** IR for Fund I = 0.212, IR for Fund II = 0.155; Fund I performed better as it has a higher IR.
**c.** IR for Fund I = 0.248, IR for Fund II = 0.224; Fund I performed better as it has a higher IR.
**d.** IR for Fund I = 0.248, IR for Fund II = 0.224; Fund II performed better as it has a lower IR.

**100.** An analyst is estimating the sensitivity of the return of stock A to different macroeconomic factors. The following estimates for the factor betas are prepared:

$$\beta_{\text{Industrial production}} = 1.3 \qquad \beta_{\text{interest rate}} = -0.75$$

Under baseline expectations, with industrial production growth of 3% and an interest rate of 1.5%, the expected return for Stock A is estimated to be 5%.

The economic research department is forecasting an acceleration of economic activity for the following year, with GDP forecast to grow 4.2% and interest rates increasing 25 basis points to 1.75%.

What return of Stock A can be expected for next year according to this forecast?

**a.** 4.8%
**b.** 6.4%
**c.** 6.8%
**d.** 7.8%

# 2016 FRM Part I Practice Exam – Answer Key

| | | | |
|---|---|---|---|
| 1.______ | 26.______ | 51.______ | 76.______ |
| 2.______ | 27.______ | 52.______ | 77.______ |
| 3.______ | 28.______ | 53.______ | 78.______ |
| 4.______ | 29.______ | 54.______ | 79.______ |
| 5.______ | 30.______ | 55.______ | 80.______ |
| 6.______ | 31.______ | 56.______ | 81.______ |
| 7.______ | 32.______ | 57.______ | 82.______ |
| 8.______ | 33.______ | 58.______ | 83.______ |
| 9.______ | 34.______ | 59.______ | 84.______ |
| 10.______ | 35.______ | 60.______ | 85.______ |
| 11.______ | 36.______ | 61.______ | 86.______ |
| 12.______ | 37.______ | 62.______ | 87.______ |
| 13.______ | 38.______ | 63.______ | 88.______ |
| 14.______ | 39.______ | 64.______ | 89.______ |
| 15.______ | 40.______ | 65.______ | 90.______ |
| 16.______ | 41.______ | 66.______ | 91.______ |
| 17.______ | 42.______ | 67.______ | 92.______ |
| 18.______ | 43.______ | 68.______ | 93.______ |
| 19.______ | 44.______ | 69.______ | 94.______ |
| 20.______ | 45.______ | 70.______ | 95.______ |
| 21.______ | 46.______ | 71.______ | 96.______ |
| 22.______ | 47.______ | 72.______ | 97.______ |
| 23.______ | 48.______ | 73.______ | 98.______ |
| 24.______ | 49.______ | 74.______ | 99.______ |
| 25.______ | 50.______ | 75.______ | 100.______ |

1. A risk manager is deciding between buying a futures contract on an exchange and buying a forward contract directly from a counterparty on the same underlying asset. Both contracts would have the same maturity and delivery specifications. The manager finds that the futures price is less than the forward price. Assuming no arbitrage opportunity exists, what single factor acting alone would be a realistic explanation for this price difference?

   **a.** The futures contract is more liquid and easier to trade.
   **b.** The forward contract counterparty is more likely to default.
   **c.** The asset is strongly negatively correlated with interest rates.
   **d.** The transaction costs on the futures contract are less than on the forward contract.

   Correct answer: c

   Explanation: When an asset is strongly negatively correlated with interest rates, futures prices will tend to be slightly lower than forward prices. When the underlying asset increases in price, the immediate gain arising from the daily futures settlement will tend to be invested at a lower than average rate of interest due to the negative correlation. In this case futures would sell for slightly less than forward contracts, which are not affected by interest rate movements in the same manner since forward contracts do not have a daily settlement feature.

   The other three choices would all most likely result in the futures price being higher than the forward price.

   **Section**: Financial Markets and Products
   **Reference**: John Hull, *Options, Futures and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 5 - Determination of Forward and Future Prices
   **Learning Objective**: Explain the relationship between forward and futures prices.

**2.** A trader in the arbitrage unit of a multinational bank finds that an asset is trading at USD 1,000, the price of a 1-year futures contract on that asset is USD 1,010, and the price of a 2-year futures contract is USD 1,025. Assume that there are no cash flows from the asset for 2 years. If the term structure of interest rates is flat at 1% per year, which of the following is an appropriate arbitrage strategy?

**a.** Short 2-year futures and long 1-year futures
**b.** Short 1-year futures and long 2-year futures
**c.** Short 2-year futures and long the underlying asset funded by borrowing for 2 years
**d.** Short 1-year futures and long the underlying asset funded by borrowing for 1 year

Correct answer: c

Explanation: The 1-year futures price should be $1{,}000 * e^{0.01} = 1{,}010.05$
The 2-year futures price should be $1{,}000 * e^{0.01*2} = 1{,}020.20$

The current 2-year futures price in the market is overvalued compared to the theoretical price. To lock in a profit, you would short the 2 year futures, borrow USD 1,000 at 1%, and buy the underlying asset. At the end of the 2nd years, you will sell the asset at USD 1,025 and return the borrowed money with interest, which would be $1{,}000 * e^{0.01*2} = 1{,}020.20$, resulting in a USD 4.80 gain.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 5 - Determination of Forward and Futures Prices
**Learning Objective**: Calculate the forward price given the underlying asset's spot price, and describe an arbitrage argument between spot and forward prices.

**3.** The price of a six-month, USD 25 strike price, European call option on a stock is USD 3. The stock price is USD 24. A dividend of USD 1 is expected in three months. The continuously compounded risk-free rate for all maturities is 5% per year. Which of the following is closest to the value of a put option on the same underlying stock with a strike price of USD 25 and a time to maturity of six months?

**a.** USD 3.60
**b.** USD 2.40
**c.** USD 4.37
**d.** USD 1.63

Correct answer: c

Explanation: From the equation for put-call parity, this can be solved by the following equation:

p = c + PV (K) + PV (D) — $S_0$

where PV represents the present value, so that

PV (K) = $K * e^{-rT}$ and PV (D) = $D * e^{-rt}$

Where:
p represents the put price,
c is the call price,
K is the strike price of the put option,
D is the dividend,
$S_0$ is the current stock price.
T is the time to maturity of the option, and
t is the time to the next dividend distribution.

Calculating PV (K), the present value of the strike price, results in a value of $25 * e^{-0.05*0.5}$ or 24.38, while PV (D) is equal to $1 * e^{-0.05*0.25}$, or 0.99. Hence p = 3 + 24.38 + 0.99 — 24 = US 4.37.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter11 - Properties of Stock Options
**Learning Objective**: Explain put-call parity and apply it to the valuation of European and American stock options.

**4.** Which of the following statements regarding the trustee named in a corporate bond indenture is correct?

- **a.** The trustee has the authority to declare a default if the issuer misses a payment.
- **b.** The trustee may take action beyond the indenture to protect bondholders.
- **c.** The trustee must act at the request of a sufficient number of bondholders.
- **d.** The trustee is paid by the bondholders or their representatives.

Correct answer: a

Explanation: According to the Trust Indenture Act, if a corporate issuer fails to pay interest or principal, the trustee may declare a default and take such action as may be necessary to protect the rights of bondholders. Trustees can only perform the actions indicated in the indenture, but are typically under no obligation to exercise the powers granted by the indenture even at the request of bondholders. The trustee is paid by the debt issuer, not by bond holders or their representatives.

**Section**: Financial Markets and Products
**Reference**: Frank Fabozzi, *The Handbook of Fixed Income Securities, 8th Edition* (New York: McGraw Hill, 2012), Chapter 12 - Corporate Bonds
**Learning Objective**: Describe a bond indenture and explain the role of the corporate trustee in a bond indenture.

**5.** Pear, Inc. is a manufacturer that is heavily dependent on plastic parts shipped from Malaysia. Pear wants to hedge its exposure to plastic price shocks over the next 7 ½ months. Futures contracts, however, are not readily available for plastic. After some research, Pear identifies futures contracts on other commodities whose prices are closely correlated to plastic prices. Futures on Commodity A have a correlation of 0.85 with the price of plastic, and futures on Commodity B have a correlation of 0.92 with the price of plastic. Futures on both Commodity A and Commodity B are available with 6-month and 9-month expirations. Ignoring liquidity considerations, which contract would be the best to minimize basis risk?

- **a.** Futures on Commodity A with 6 months to expiration
- **b.** Futures on Commodity A with 9 months to expiration
- **c.** Futures on Commodity B with 6 months to expiration
- **d.** Futures on Commodity B with 9 months to expiration

Correct answer: d

Explanation: In order to minimize basis risk, one should choose the futures contract with the highest correlation to price changes, and the one with the closest maturity, preferably expiring after the duration of the hedge.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 3 - Hedging Strategies Using Futures
**Learning Objective**: Define the basis and explain the various sources of basis risk, and explain how basis risks arise when hedging with futures.

**6.** An analyst is examining the exchange rate between the U.S. dollar and the euro and is given the following information regarding the USD/EUR exchange rate and the respective domestic risk-free rates:

Current USD/EUR exchange rate is 1.25
Current USD-denominated 1-year risk-free interest rate is 4% per year
Current EUR-denominated 1-year risk-free interest rate is 7% per year

According to the interest rate parity theorem, what is the 1-year forward USD/EUR exchange rate?

**a.** 0.78
**b.** 0.82
**c.** 1.21
**d.** 1.29

Correct answer: c

Explanation: The forward rate, FT, is given by the interest rate parity equation:

$$F_t = S_0 * e^{(r-r_f)t}$$

where

$S_0$ is the spot exchange rate,
r is the domestic (USD) risk-free rate, and
$r_f$ is the foreign (EUR) risk-free rate
T is the time to delivery

Substituting the values in the equation:

$$F_t = 1.25 * e^{(0.04-0.07)} = 1.21$$

**Section**: Financial Markets and Products
**Reference**: Anthony Saunders and Marcia Millon Cornett, *Financial Institutions Management: A Risk Management Approach, 8th Edition* (New York: McGraw-Hill, 2014), Chapter13 – Foreign Exchange Risk
**Learning Objective**: Describe how a no-arbitrage assumption in the foreign exchange markets leads to the interest rate parity theorem, and use this theorem to calculate forward foreign exchange rates.

**7.** An investor sells a January 2014 call on the stock of XYZ Limited with a strike price of USD 50 for USD 10, and buys a January 2014 call on the same underlying stock with a strike price of USD 60 for USD 2. What is the name of this strategy, and what is the maximum profit and loss the investor could incur at expiration?

| | *Strategy* | *Maximum Profit* | *Maximum Loss* |
|---|---|---|---|
| **e.** | Bear spread | USD 8 | USD 2 |
| **f.** | Bull spread | USD 8 | Unlimited |
| **g.** | Bear spread | Unlimited | USD 2 |
| **h.** | Bull spread | USD 8 | USD 2 |

Correct answer: a

Explanation: This strategy of buying a call option at a higher strike price and selling a call option at lower strike price with the same maturity is known as a bear spread. To establish a bull spread, one would buy the call option at a lower price and sell a call on the same security with the same maturity at a higher strike price.

The cost of the strategy will be:

USD -10 + USD 2 = USD -8 (a negative cost, which represents an inflow of USD 8 to the investor)

The maximum payoff occurs when the stock price $S_T \leq$ USD 50 and is equal to USD 8 (the cash inflow from establishing the position) as none of the options will be exercised. The maximum loss occurs when the stock price $S_T \geq 60$ at expiration, as both options will be exercised. The investor would then be forced to sell XYZ shares at 50 to meet the obligations on the call option sold, but could exercise the second call to buy the shares back at 60 for a loss of USD -10. However, since the investor received an inflow of USD 8 by establishing the strategy, the total profit would be USD 8 - USD 10 = USD -2.

When the stock price is USD 50 < $S_T \leq$ USD 60, only the call option sold by the investor would be exercised, hence the payoff will be $50 — S_T$. Since the inflow from establishing the original strategy was USD 8, the net profit will be $58 — S_T$, which would always be higher than USD -2.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson 2014), Chapter 11 - Properties of Stock Options
**Learning Objective**: Identify and compute upper and lower bounds for option prices on non-dividend and dividend paying stocks.

**8.** An analyst is trying to get some insight into the relationship between the return on stock LMD ($R_{LMD,t}$) and the return on the S&P 500 index ($R_{S\&P,t}$). Using historical data, the analyst estimates the following:

| | |
|---|---|
| Annual mean return for LMD: | 11% |
| Annual mean return for S&P 500 index: | 7% |
| Annual volatility for S&P 500 index: | 18% |
| Covariance between the returns of LMD and S&P 500 index: | 6% |

Assuming the analyst uses the same data to estimate the regression model given by:

$R_{LMD,t} = \alpha + \beta R_{S\&P,t} + \varepsilon_t$

Using the ordinary least squares technique, which of the following models will the analyst obtain?

**a.** $R_{LMD,t} = -0.02 + 0.54R_{S\&P,t} + \varepsilon_t$
**b.** $R_{LMD,t} = -0.02 + 1.85R_{S\&P,t} + \varepsilon_t$
**c.** $R_{LMD,t} = 0.04 + 0.54R_{S\&P,t} + \varepsilon_t$
**d.** $R_{LMD,t} = 0.04 + 1.85R_{S\&P,t} + \varepsilon_t$

Correct answer: b

Explanation: The regression coefficients for a model specified by Y = b X + a + ε are obtained using the formula:

$b = S_{XY} / S^2$

In this example:
$S_{XY} = 0.06$
$S_X = 0.18$
$E(Y) = 0.11$
Then:

$b = 0.06 / (0.18)^2 = 1.85$
$a = E(Y) - b*E(X) = 0.11 - (1.85*0.07) = -0.02$

where ε represents the error term.

**Section**: Quantitative Analysis
**Reference**: James Stock and Mark Watson, *Introduction to Econometrics, Brief Edition* (Boston: Pearson Education, 2008), Chapter 4 – Linear Regression with One Regressor
**Learning Objective**: Explain how regression analysis in econometrics measures the relationship between dependent and independent variables.

**9.** For a sample of 400 firms, the relationship between corporate revenue ($Y_i$) and the average years of experience per employee ($X_i$) is modeled as follows:

$Y_i = \beta_1 + \beta_2 X_i + \varepsilon_i, \quad i = 1, 2, ..., 400$

You wish to test the joint null hypothesis that $\beta_1 = 0$ and $\beta_2 = 0$ at the 95% confidence level. The p-value for the t-statistic for $\beta_1$ is 0.07, and the p-value for the t-statistic for $\beta_2$ is 0.06. The p-value for the F-statistic for the regression is 0.045. Which of the following statements is correct?

**a.** You can reject the null hypothesis because each β is different from 0 at the 95% confidence level.
**b.** You cannot reject the null hypothesis because neither β is different from 0 at the 95% confidence level.
**c.** You can reject the null hypothesis because the F-statistic is significant at the 95% confidence level.
**d.** You cannot reject the null hypothesis because the F-statistic is not significant at the 95% confidence level.

Correct answer: c

Explanation: The t-test would not be sufficient to test the joint hypothesis. In order to test the joint null hypothesis, examine the F-statistic, which in this case is statistically significant at the 95% confidence level. Thus the null can be rejected.

**Section**: Quantitative Analysis
**Reference**: James Stock and Mark Watson, *Introduction to Econometrics, Brief edition* (Boston, Pearson Education, 2008), Chapter 7 - Hypothesis Tests and Confidence Intervals in Multiple Regression
**Learning Objective**: Interpret tests of a single restriction involving multiple coefficients; Interpret the F-statistic.

**10.** A fixed income portfolio manager currently holds a portfolio of bonds of various companies. Assuming all these bonds have the same annualized probability of default and that the defaults are independent, the number of defaults in this portfolio over the next year follows which type of distribution?

- **a.** Bernoulli
- **b.** Normal
- **c.** Binomial
- **d.** Exponential

Correct answer: c

Explanation: The result would follow a Binomial distribution as there is a fixed number of random variables, each with the same annualized probability of default. It is not a Bernoulli distribution, as a Bernoulli distribution would describe the likelihood of default of one of the individual bonds rather than of the entire portfolio (i.e. a Binomial distribution essentially describes a group of Bernoulli distributed variables). A normal distribution is used to model continuous variables, while in this case the number of defaults within the portfolio is discrete.

**Section**: Quantitative Analysis
**References**: Michael Miller, *Mathematics and Statistics for Financial Risk Management* (Hoboken, NJ: John Wiley & Sons, 2012), Chapter 4 - Distributions
**Learning Objective**: Distinguish the key properties among the following distributions: uniform distribution, Bernoulli distribution, Binomial distribution, Poisson distribution, normal distribution, lognormal distribution, Chi-squared distribution, Student's t, and F-distributions, and identify common occurrences of each distribution.

**11.** An analyst has been asked to check for arbitrage opportunities in the Treasury bond market by comparing the cash flows of selected bonds with the cash flows of combinations of other bonds. If a 1-year zero-coupon bond is priced at USD 96.12 and a 1-year bond paying a 10% coupon semi-annually is priced at USD 106.20, what should be the price of a 1-year Treasury bond that pays a coupon of 8% semi-annually?

**a.** USD 98.10
**b.** USD 101.23
**c.** USD 103.35
**d.** USD 104.18

Correct answer: d

Explanation: The solution is to replicate the 1 year 8% bond using the other two treasury bonds. In order to replicate the cash flows of the 8% bond, you could solve a system of equations to determine the weight factors, F1 and F2, which correspond to the proportion of the zero and the 10% bond to be held, respectively.

The two equations are as follows:

(100 * F1) + (105 * F2) = 104 (replicating the cash flow including principal and interest payments at the end of 1 year),

and

(5 * F2) = 4 (replicating the cash flow from the coupon payment in 6 months.)

Solving the two equations gives us F1 = 0.2 and F2 = 0.8. Thus the price of the 8% bond should be 0.2 (96.12) + 0.8 (106.2) = 104.18.

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: Wiley & Sons, 2011), Chapter 1 - Prices, Discount Factors, and Arbitrage
**Learning Objective**: Construct a replicating portfolio using multiple fixed income securities to match the cash flows of a given fixed income security.

**12.** If the current market price of a stock is USD 50, which of the following options on the stock has the highest gamma?

**a.** Call option expiring in 30 days with strike price of USD 50
**b.** Call option expiring in 5 days with strike price of USD 30
**c.** Call option expiring in 5 days with strike price of USD 50
**d.** Put option expiring in 30 days with strike price of USD 30

Correct answer: c

Explanation: Gamma is defined as the rate of change of an option's delta with respect to the price of the underlying asset, or the second derivative of the option price with respect to the asset price. Therefore the highest gamma is observed in shorter maturity and at-the-money options, since options with these characteristics are much more sensitive to changes in the underlying asset price.

The correct choice is a call option both at-the-money and with the shorter maturity.

**Section**: Valuation and Risk Models
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 19 — The Greek Letters
**Learning Objective**: Define and describe theta, gamma, vega, and rho for option positions.

**13.** An investment advisor is advising a wealthy client of the company. The client would like to invest USD 500,000 in a bond rated at least AA. The advisor is considering bonds issued by Company X, Company Y, and Company Z, and wants to choose a bond that satisfies the client's rating requirement, but also has the highest yield to maturity. The advisor has gathered the following information:

| | X | Y | Z |
|---|---|---|---|
| Bond Rating | A | A+ | AAA |
| Semiannual | 1.7 | 1.7 | 1.69 |
| Term to Maturity in | 5 | 5 | 5 |
| Price (USD) | 97 | 97 | 989 |
| Par value (USD) | 10 | 10 | 1000 |

Which bond should the investment advisor purchase for the client?

**a.** Y bond
**b.** X bond
**c.** Z bond
**d.** Either the Z bond or the Y bond

Correct answer: b

Explanation: To reach the correct answer, find the bond with the highest yield to maturity (YTM) that qualifies for inclusion in the client's portfolio. Although we can calculate the YTM for each bond using a modern business calculator, it is unnecessary to do so in this case. Of the three bonds, the Y bond does not qualify for the portfolio as its rating of A+ is below the AA rating required by the client. This leaves the X bond and the Z bond. Comparing the two bonds, the X bond pays a higher coupon than the Z bond, yet it is cheaper as well. Therefore the yield on the X bond is higher.

To formally calculate the yield, you could also use the following equation describing the relationship between price and yield:

$$P = \frac{c}{y}\left[1 - \left(\frac{1}{1+y/2}\right)^{2T}\right] + F\left(\frac{1}{1+y/2}\right)^{2T}$$

Using this equation (or an equivalent calculator function), the YTM for the X bond equals 4.057%, while the YTM for the Z bond equals 3.62%.

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: Wiley & Sons, 2011), Chapter 3 — Returns, Spreads and Yields
**Learning Objective**: Compute a bond's YTM given a bond structure and price.

**14.** After evaluating the results of a firm's stress tests, an analyst is recommending that the firm allocate additional economic capital and purchase selective insurance protection to guard against particular events. In order to give management a fully informed assessment, it is important that the following is noted related to this strategy:

**a.** While decreasing liquidity risk exposure, it will likely increase market risk exposure.
**b.** While decreasing correlation risk exposure, it will likely increase credit risk exposure.
**c.** While decreasing market risk exposure, it will likely increase credit risk exposure.
**d.** While decreasing credit risk exposure, it will likely increase model risk exposure.

Correct answer: c

Explanation: The purchase of insurance protection can transform market risk into counterparty credit risk.

**Section**: Valuation and Risk Models
**Reference**: Philippe Jorion, Value-at-Risk: *The New Benchmark for Managing Financial Risk, 3rd Edition* (New York: McGraw-Hill 2007), Chapter 14 – Stress Testing
**Learning Objective**: Explain how the results of a stress test can be used to improve risk analysis and risk management systems.

**15.** A portfolio manager bought 1,000 call options on a non-dividend-paying stock, with a strike price of USD 100, for USD 6 each. The current stock price is USD 104 with a daily stock return volatility of 1.89%, and the delta of the option is 0.6. Using the delta-normal approach to calculate VaR, what is an approximation of the 1-day 95% VaR of this position?

**a.** USD 112
**b.** USD 1,946
**c.** USD 3,243
**d.** USD 5,406

Correct answer: b

Explanation:
The delta of the option is 0.6. The VaR of the underlying is:

1.89% * 1.65 * 104 = 3.24

Therefore, the VaR of one option is:

0.6*3.24=1.946, and multiplying by 1,000 provides the VaR of the entire position: 1,946.

**Section**: Valuation and Risk Models
**Reference**: Linda Allen, Jacob Boudoukh and Anthony Saunders (2004), *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (Oxford, Blackwell Publishing, 2004), Chapter 3 – Putting VaR to Work
**Learning Objective**: Describe the delta-normal approach for calculating VaR for non-linear derivatives.

**16.** Which of the following statements concerning the measurement of operational risk is correct?

- **a.** Economic capital should be sufficient to cover both expected and worst-case operational risk losses.
- **b.** Loss severity and loss frequency tend to be modeled with lognormal distributions.
- **c.** Operational loss data available from data vendors tend to be biased towards small losses.
- **d.** The standardized approach used by banks in calculating operational risk capital allows for different beta factors to be assigned to different business lines.

Correct answer: d

Explanation: In the standardized approach to calculating operational risk, a bank's activities are divided up into several different business lines, and a beta factor is calculated for each line of business. Economic capital covers the difference between the worst-case loss and the expected loss. Loss severity tends to be modeled with a lognormal distribution, but loss frequency is typically modeled using a Poisson distribution. Operational loss data available from data vendors tends to be biased towards large losses.

**Section**: Valuation and Risk Models
**Reference**: John Hull, *Risk Management and Financial Institutions, 4th Edition* (Hoboken, NJ: John Wiley & Sons, 2015), Chapter23— Operational Risk
**Learning Objective**: Describe the allocation of operational risk capital to business units.

**17.** The proper selection of factors to include in an ordinary least squares estimation is critical to the accuracy of the result. When does omitted variable bias occur?

**a.** Omitted variable bias occurs when the omitted variable is correlated with the included regressor and is a determinant of the dependent variable.
**b.** Omitted variable bias occurs when the omitted variable is correlated with the included regressor but is not a determinant of the dependent variable.
**c.** Omitted variable bias occurs when the omitted variable is independent of the included regressor and is a determinant of the dependent variable.
**d.** Omitted variable bias occurs when the omitted variable is independent of the included regressor but is not a determinant of the dependent variable.

Correct answer: a

Explanation: Omitted variable bias occurs when a model improperly omits one or more variables that are critical determinants of the dependent variable and are correlated with one or more of the other included independent variables. Omitted variable bias results in an over- or under-estimation of the regression parameters.

**Section:** Quantitative Analysis
**Reference:** James Stock and Mark Watson (2008), *Introduction to Econometrics, Brief Edition* (Boston, Pearson Education, 2008), Chapter 6 – Linear Regression with Multiple Regressors
**Learning objective:** Define and interpret omitted variable bias, and describe the methods for addressing this bias.

**18.** Assume that an investor is only concerned with systematic risk. Which of the following would be the best measure to use to rank order funds with different betas based on their risk-return relationship with the market portfolio?

**a.** Treynor ratio
**b.** Sharpe ratio
**c.** Jensen's alpha
**d.** Sortino ratio

Correct answer: a

Explanation: Systematic risk of a portfolio is that risk which is inherent in the market and thus cannot be diversified away. In this situation you should seek a measure which ranks funds based on systematic risk only, which is reflected in the beta as defined below:
$\beta_P = (\rho_{PM} * \sigma_P * \sigma_M)/\sigma^2$

where $\rho_{PM}$ is the correlation coefficient between the portfolio and the market, $\sigma_p$ represents the standard deviation of the portfolio and $\sigma_M$ represents the standard deviation of the market. In a well-diversified portfolio (where one is normally only concerned with systematic risk), it can be assumed that the correlation coefficient is close to 1, therefore beta can be approximated to an even simpler equation:

$\beta_P \approx \sigma_P / \sigma_M$

In either case, beta explains the volatility of the portfolio compared to the volatility of the market, which captures only systematic risk.

The Treynor ratio is the correct ratio to use in this case. The formula is: $T_p = [E(R_p) - R_f] / \beta_p$ which describes the difference between the expected return of the portfolio, $E(R_p)$ and the risk free rate $R_f$ divided by the portfolio beta $\beta$. Therefore, it plots excess return over systematic risk.

**Section**: Foundations of Risk Management
**Reference**: Noel Amenc and Veronique Le Sourd, Portfolio Theory and Performance Analysis (West Sussex, England: Wiley, 2003), Chapter 4, Section 4.2 — Applying the CAPM to Performance Measurement: Single-Index Performance Measurement Indicators
**Learning Objective**: Calculate, compare, and evaluate the Treynor measure, the Sharpe measure, and Jensen's alpha.

**19.** The collapse of Long Term Capital Management (LTCM) is a classic risk management case study. Which of the following statements about risk management at LTCM is correct?

**a.** LTCM had no active risk reporting.
**b.** At LTCM, stress testing became a risk management department exercise that had little influence on the firm's strategy.
**c.** LTCM's use of high leverage is evidence of poor risk management.
**d.** LTCM failed to account properly for the illiquidity of its largest positions in its risk calculations.

Correct answer: d

Explanation: A major contributing factor to the collapse of LTCM is that it did not account properly for the illiquidity of its largest positions in its risk calculations. LTCM received valuation reports from dealers who only knew a small portion of LTCM's total position in particular securities, therefore understating LTCM's true liquidity risk. When the markets became unsettled due to the Russian debt crisis in August 1998 and a separate firm decided to liquidate large positions which were similar to many at LTCM, the illiquidity of LTCM's positions forced it into a situation where it was reluctant to sell and create an even more dramatic adverse market impact even as its equity was rapidly deteriorating. To avert a full collapse, LTCM's creditors finally stepped in to provide $3.65 billion in additional liquidity to allow LTCM to continue holding its positions through the turbulent market conditions in the fall of 1998. However, as a result, investors and managers in LTCM other than the creditors themselves lost almost all their investment in the fund.

**Section**: Foundations of Risk Management
**Reference**: Steve Allen, *Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk, 2nd Edition* (New York: John Wiley & Sons, 2013), Chapter 4 — Financial Disasters
**Learning Objective**: Analyze the key factors that led to and derive the lessons learned from the following risk management case studies: Long Term Capital Management (LTCM)

**20.** Which of the following is a potential consequence of violating the GARP Code of Conduct once a formal determination is made that such a violation has occurred?

**a.** Formal notification to the GARP Member's employer of such a violation
**b.** Suspension of the GARP Member's right to work in the risk management profession
**c.** Removal of the GARP Member's right to use the FRM designation
**d.** Required participation in ethical training

Correct answer: c

Explanation: According to the GARP Code of Conduct, violation(s) of this Code may result in, among other things, the temporary suspension or permanent removal of the GARP Member from GARP's Membership roles, and may also include temporarily or permanently removing from the violator the right to use or refer to having earned the FRM designation or any other GARP granted designation, following a formal determination that such a violation has occurred.

**Section**: Foundations of Risk Management
**Reference**: GARP Code of Conduct, Applicability and Enforcement section.
**Learning objective**: Describe the potential consequences of violating the GARP Code of Conduct.

**21.** Which of the following is assumed in the multiple least squares regression model?

**a.** The dependent variable is stationary.
**b.** The independent variables are not perfectly multicollinear.
**c.** The error terms are heteroskedastic.
**d.** The independent variables are homoskedastic.

Correct answer: b

Explanation: One of the assumptions of the multiple regression model of least squares is that no perfect multi- collinearity is present. Perfect multicollinearity would exist if one of the regressors is a perfect linear function of the other regressors.

None of the other choices are assumptions of the multiple least squares regression model.

**Section**: Quantitative Analysis
**Reference**: James Stock and Mark Watson, *Introduction to Econometrics, Brief Edition* (Boston, Pearson Education, 2008), Chapter 6 – Linear Regression with Multiple Regressors
**Learning Objective**: Explain the assumptions of the multiple linear regression model.

**22.** A bank's risk manager is considering different viewpoints for reporting data quality metrics within a data quality scorecard: a data quality issues viewpoint, a business process viewpoint, and a business impact viewpoint. For which of the following purposes would a business process viewpoint be most effective?

**a.** Aggregating the business impacts of poor quality data across different business processes.
**b.** Creating a high-level overview of risks associated with data issues on the trading desk.
**c.** Isolating the point at which data issues begin to arise in a foreign exchange hedging procedure.
**d.** Identifying organizational processes that require enhanced monitoring and control.

Correct answer: c

Explanation: A business process view would be the best choice when the firm is looking to isolate the specific point within a business process where data quality issues are introduced, as in this example.

**Section**: Foundations of Risk Management
**Reference**: Anthony Tarantino and Deborah Cernauskas, *Risk Management in Finance: Six Sigma and other Next Generation Techniques* (Hoboken, NJ, John Wiley & Sons 2009), Chapter 3 - Information Risk and Data Quality Management
**Learning Objective**: Describe the operational data governance process, including the use of scorecards in managing information risk.

**23.** Suppose the S&P 500 has an expected annual return of 7.6% and volatility of 10.8%. Suppose the Atlantis Fund has an expected annual return of 8.3% and volatility of 8.8% and is benchmarked against the S&P 500. If the risk-free rate is 2.0% per year, what is the beta of the Atlantis Fund according to the Capital Asset Pricing Model?

**a.** 0.81
**b.** 0.89
**c.** 1.13
**d.** 1.23

Correct answer: c

Explanation: Since the correlation or covariance between the Atlantis Fund and the S&P 500 is not known, CAPM must be used to back out the beta: $\overline{R_i} = R_F + \beta_i * (\overline{R_M} - R_F)$.

Therefore:

$8.3\% = 2.0\% + \beta_i * (7.6\% - 2.0\%)$; hence $\beta_i = \frac{(8.3\% - 2.0\%)}{(7.6\% - 2.0\%)}$ $or\ 1.13$

**Section**: Foundations of Risk Management
**Reference**: Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann, *Modern Portfolio Theory and Investment Analysis, 9th Edition* (Hoboken, NJ: John Wiley & Sons, 2014) Chapter 13 – The Standard Capital Asset Pricing Model
**Learning Objective**: Apply the CAPM in calculating the expected return on an asset; Interpret beta and calculate the beta of a single asset or portfolio.

**24.** In October 1994, General Electric sold Kidder Peabody to Paine Webber, which eventually dismantled the firm. Which of the following led up to the sale?

- **a.** Kidder Peabody had its primary dealer status revoked by the Federal Reserve after it was found to have submitted fraudulent bids at US Treasury auctions.
- **b.** Kidder Peabody reported a large quarterly loss from highly leveraged positions, which left the company insolvent and on the verge of bankruptcy.
- **c.** Kidder Peabody suffered a large loss when counterparties to its CDS portfolio could not honor their contracts, which left the company with little equity.
- **d.** Kidder Peabody reported a sudden large accounting loss to correct an error in the firm's accounting system, which called into question the management team's competence.

Correct answer: d

Explanation: Kidder Peabody's accounting system failed to account for the present value of forward trades, which allowed trader Joseph Jett to book an instant, but fraudulent, accounting profit by purchasing cash bonds to be delivered at a later date. These profits would dissipate as the bonds approached their delivery date, but Jett cov- ered this up by rolling the positions forward with increasingly greater positions and longer lengths to delivery, which created a higher stream of hypothetical profits due to the accounting flaw. Finally this stream of large profits was investigated and Kidder Peabody was forced to take a USD 350 million accounting loss to reverse the reported gains, which resulted in a loss of confidence in the firm and General Electric's subsequent sale.

**Section**: Foundations of Risk Management
**Reference**: Steve Allen, Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk (New York: John Wiley & Sons, 2012), Chapter 4: Financial Disasters.
**Learning Objective**: Analyze the key factors that led to and derive the lessons learned from the following risk management case studies: Kidder Peabody.

**25.** An analyst is evaluating the performance of a portfolio of Mexican equities that is benchmarked to the IPC Index. The analyst collects the information about the portfolio and the benchmark index shown in the table below:

| | |
|---|---|
| Expected return on the portfolio | 6.6% |
| Volatility of returns on the portfolio | 13.1% |
| Expected return on the IPC Index | 4.0% |
| Volatility of returns on the IPC Index | 8.7% |
| Risk-free rate of return | 1.5% |
| Beta of portfolio relative to IPC Index | 1.4 |

What is the Sharpe ratio for this portfolio?

**a.** 0.036
**b.** 0.047
**c.** 0.389
**d.** 0.504

Correct answer: c

Explanation: The Sharpe ratio for the portfolio is $\frac{Expected\ Return\ on\ Portfolio - Risk\ Free\ Rate}{Volatility\ of\ Returns\ of\ Portfolio} = \frac{6.6\% - 1.5\%}{13.1\%} = 0.389$

**Section**: Foundations of Risk Management
**Reference**: Noel Amenc and Veronique Le Sourd, *Portfolio Theory and Performance Analysis* (West Sussex, England: Wiley, 2003), Chapter 4, Section 4.2 — Applying the CAPM to Performance Measurement: Single-Index Performance Measurement Indicators.
**Learning Objective**: Calculate, compare, and evaluate the Treynor measure, the Sharpe measure, and Jensen's alpha.

**26.** A risk manager has estimated a regression of a firm's monthly portfolio returns against the returns of three U.S. domestic equity indexes: the Russell 1000 index, the Russell 2000 index, and the Russell 3000 index. The results are shown below.

| Regression Statistics | |
|---|---|
| Multiple R | 0.9 |
| R Square | 0.9 |
| Adjusted R Square | 0.9 |
| Standard Error | 0.0 |
| Observations | 192 |

| Regression Output | Coefficients | Standard Error | t-Stat | P-value |
|---|---|---|---|---|
| Intercept | 0.0023 | 0.0006 | 3.530 | 0.0005 |
| Russell 1000 | 0.1093 | 1.5895 | 0.068 | 0.9452 |
| Russell 2000 | 0.1055 | 0.1384 | 0.762 | 0.4470 |
| Russell 3000 | 0.3533 | 1.7274 | 0.204 | 0.8382 |

| Correlation Matrix | Portfolio Returns | Russell 1000 | Russell 2000 | Russell 3000 |
|---|---|---|---|---|
| Portfolio | 1.000 | | | |
| Russell 1000 | 0.937 | 1.000 | | |
| Russell 2000 | 0.856 | 0.813 | 1.000 | |
| Russell 3000 | 0.945 | 0.998 | 0.845 | 1.000 |

Based on the regression results, which statement is correct?

**a.** The estimated coefficient of 0.3533 indicates that the returns of the Russell 3000 index are more statistically significant in determining the portfolio returns than the other two indexes.

**b.** The high adjusted $R^2$ indicates that the estimated coefficients on the Russell 1000, Russell 2000, and Russell 3000 indexes are statistically significant.

**c.** The high p-value of 0.9452 indicates that the regression coefficient of the returns of Russell 1000 is more statistically significant than the other two indexes.

**d.** The high correlations between each pair of index returns indicate that multicollinearity exists between the variables in this regression.

Correct answer: d

Explanation: This is an example of multicollinearity, which arises when one of the regressors is very highly correlated with the other regressors. In this case, all three regressors are highly correlated with each other, so multicollinearity exists between all three. Since the variables are not perfectly correlated with each other this is a case of imperfect, rather than perfect, multicollinearity.

**Section**: Quantitative Analysis
**Reference**: Stock and Watson, *Introduction to Econometrics, Brief Edition* (Boston: Pearson Education, 2008).
Chapter 6 - Linear Regression with Multiple Regressors
Chapter 7 - Hypothesis Tests and Confidence Intervals in Multiple Regression
**Learning Objective**: Interpret the slope coefficient in a multiple regression.
Interpret the $R^2$ and adjusted-$R^2$ in a multiple regression.
Explain the concepts of imperfect and perfect multicollinearity and their implications.

**27.** An analyst is examining a portfolio that consists of 600 subprime mortgages and 400 prime mortgages. Of the subprime mortgages, 120 are late on their payments. Of the prime mortgages, 40 are late on their payments. If the analyst randomly selects a mortgage from the portfolio and it is currently late on its payments, what is the probability that it is a subprime mortgage?

**a.** 60%
**b.** 67%
**c.** 75%
**d.** 80%

Correct answer: c

Explanation: In order to solve this conditional probability question, first calculate the probability that any one mortgage in the portfolio is late. This is: P(Mortgage is late) = (120 + 40)/1000 = 16%.

Next use the conditional probability relationship as follows:
P (Mortgage subprime | Mortgage is late) = P(Mortgage subprime and late) / P(Mortgage is late)
Since P(Mortgage subprime and late) = 120/1000 = 12%;
therefore P(Mortgage subprime | Mortgage is late) = 12% / 16% = 0.75 = 75%.

Hence the probability that a random late mortgage selected from this portfolio turns out to be subprime is 75%.

**Section**: Quantitative Analysis
**Reference**: Mike Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013). Chapter 2 - Probabilities
**Learning Objective**: Define and calculate a conditional probability, and distinguish between conditional and unconditional probabilities.

**28.** An analyst is testing a hypothesis that the beta, $\beta$, of stock CDM is 1. The analyst runs an ordinary least squares regression of the monthly returns of CDM, $R_{CDM}$, on the monthly returns of the S&P 500 index, $R_m$, and obtains the following relation:

$R_{CDM} = 0.86\ R_m - 0.32$

The analyst also observes that the standard error of the coefficient of $R_m$ is 0.80. In order to test the hypothesis H0: $\beta = 1$ against H1: $\beta \neq 1$, what is the correct statistic to calculate?

**a.** t-statistic
**b.** Chi-square test statistic
**c.** Jarque-Bera test statistic
**d.** Sum of squared residuals

Correct answer: a

Explanation: The correct test is the t test. The t statistic is defined by:

$$t = \frac{\beta^{estimated} - \beta}{SE\ (estimated\ \beta)} = \frac{0.86 - 1}{0.8}$$

In this case t = -0.175. Since |t| < 1.96 we cannot reject the null hypothesis.

**Section**: Quantitative Analysis
**Reference**: Stock and Watson, *Introduction to Econometrics, Brief Edition* (Boston: Pearson, 2008), Chapter 5 – Regression with a Single Regressor
**Learning Objective**: Interpret hypothesis tests about regression coefficients.

**29.** Which of the following statements about the exponentially weighted moving average (EWMA) model and the generalized autoregressive conditional heteroscedasticity (GARCH(1,1)) model is correct?

**a.** The EWMA model is a special case of the GARCH(1,1) model with the additional assumption that the long-run volatility is zero.
**b.** A variance estimate from the EWMA model is always between the prior day's estimated variance and the prior day's squared return.
**c.** The GARCH(1,1) model always assigns less weight to the prior day's estimated variance than the EWMA model.
**d.** A variance estimate from the GARCH(1,1) model is always between the prior day's estimated variance and the prior day's squared return.

Correct answer: b

Explanation: The EWMA estimate of variance is a weighted average of the prior day's variance and prior day squared return.

**Section**: Quantitative Analysis
**Reference**: John Hull, Options, *Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 23 - Estimating Volatilities and Correlations for Risk Management
**Learning Objective**: Apply the exponentially weighted moving average (EWMA) model to estimate volatility.
Describe the generalized autoregressive conditional heteroskedasticity (GARCH(p,q)) model for estimating volatility and its properties.

**30.** A risk manager is examining a Hong Kong trader's profit and loss record for the last week, as shown in the table below:

| Trading Day | Profit/Loss (HKD million) |
|---|---|
| Monday | 10 |
| Tuesday | 80 |
| Wednesda | 90 |
| Thursday | -60 |
| Friday | 30 |

The profits and losses are normally distributed with a mean of 4.5 million HKD and assume that transaction costs can be ignored. Part of the t-table is provided below:

Percentage Point of the t-Distribution $P(T>t)=\alpha$

| Degrees of Freedom | 0. 3 | 0. 2 |
|---|---|---|
| 4 | 0. | 0.9 |
| 5 | 0. | 0.9 |

According to the information provided above, what is the probability that this trader will record a profit of at least HKD 30 million on the first trading day of next week?

**a.** About 15%
**b.** About 20%
**c.** About 80%
**d.** About 85%

Correct answer: b

Explanation: When the population mean and population variance are not known, the t-statistic can be used to analyze the distribution of the sample mean.

Sample mean = (10 + 80 + 90 - 60 + 30)/5 = 30
Unbiased sample variance = (1/4)[ (-20)^2 + 50^2 + 60^2 + (-90)^2 + 0^2 ] = 14600/4 = 3650
Unbiased sample standard deviation = 60.4152
Sample standard error = (sample standard deviation)/√5 = 27.0185
Population mean of return distribution = 4.5 (million HKD)
Therefore the t-statistic = (Sample mean – population mean)/Sample standard error = (30 - 4.5)/27.02 = 0.9438.

Because we are using the sample mean in the analysis, we must remove 1 degree of freedom before consulting the t-table; therefore 4 degrees of freedom are used. According to the table, the closest possibility is 0.2 = 20%.

**Section**: Quantitative Analysis
**References**: Stock and Watson, *Introduction to Econometrics, Brief Edition* (Boston: Pearson, 2008) Chapter 5 - Regression with a Single Regressor
**Learning Objective**: Apply and interpret the t-statistic when the sample size is small.

**31.** An experienced commodities risk manager is examining corn futures quotes from the CME Group. Which of the following observations would the risk manager most likely view as a potential problem with the quotation data?

**a.** The volume in a specific contract is greater than the open interest.
**b.** The prices indicate a mixture of normal and inverted markets.
**c.** The settlement price for a specific contract is above the high price.
**d.** There is no contract with maturity in a particular month.

Correct answer: c

Explanation: The reported high price of a futures contract should reflect all prices for the day, so the settlement price should never be greater than the high price.

**Section**: Financial Markets and Products
**Reference**: John Hull, Options, *Futures and Other Derivatives, 9th Edition* (New York, Pearson, 2014), Chapter 2: Mechanics of Futures Markets.
**Learning Objective**: Define and describe the key features of a futures contract, including the asset, the contract price and size, delivery and limits.

**32.** A portfolio manager controls USD 88 million par value of zero-coupon bonds maturing in 5 years and yielding 4%. The portfolio manager expects that interest rates will increase. To hedge the exposure, the portfolio manager wants to sell part of the 5-year bond position and use the proceeds from the sale to purchase zero-coupon bonds maturing in 1.5 years and yielding 3%. What is the market value of the 1.5-year bonds that the portfolio manager should purchase to reduce the duration on the combined position to 3 years?

**a.** USD 41.17 million
**b.** USD 43.06 million
**c.** USD 43.28 million
**d.** USD 50.28 million

Correct answer: a

Explanation: In order to find the proper amount, we first need to calculate the current market value of the portfolio (P), which is:

P = 88 * exp (-0.04 * 5) = 72.05 million.

The desired portfolio duration (after the sale of the 5-year bond and purchase of the 1.5 year bond) can be expressed as:

[5 * (P-X) + 1.5* X]/P = 3 where X represents the market value of the zero-coupon bond with a maturity of 1.5 years.
This equation holds true when X = (4/7) * P, or 41.17 million.

**Section**: Financial Markets and Products
**Reference**: Hull, Options, *Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 4 - Interest Rates.
**Learning Objective**: Calculate the change in a bond's price given its duration, its convexity, and a change in interest rates.

**33.** A 15-month futures contract on an equity index is currently trading at USD 3,767.52. The underlying index is currently valued at USD 3,625 and has a continuously-compounded dividend yield of 2% per year. The continuously compounded risk-free rate is 5% per year. Assuming no transactions costs, what is the potential arbitrage profit per contract and the appropriate strategy?

**a.** USD 189, buy the futures contract and sell the underlying.
**b.** USD 4, buy the futures contract and sell the underlying.
**c.** USD 189, sell the futures contract and buy the underlying.
**d.** USD 4, sell the futures contract and buy the underlying.

Correct answer: d

Explanation: This is an example of index arbitrage. The no-arbitrage value of the futures contract can be calculated as the future value of the spot price: $S_0 * e^{(\text{risk-free} - \text{dividend yield}) \times t}$, where $S_0$ equals the current spot price and t equals the time in years.

Future value of the spot price = $S_0$ * exp[(risk free rate — dividend yield) * 1.25] = 3,763.52

Since this value is different from the current futures contract price, a potential arbitrage situation exists. Since the futures price is higher than the future value of the spot price in this case, one can short sell the higher priced futures contract, and buy the underlying stocks in the index at the current price. The arbitrage profit would equal 3,767.52 - 3,763.52 = USD 4.

**Section**: Financial Markets and Products
**Reference**: John Hull, Options, *Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 5 – Determination of Forward and Future Prices
**Learning Objective**: Calculate the forward price given the underlying asset's spot price, and describe an arbitrage argument between spot and forward prices.

**34.** Savers Bancorp entered into a swap agreement over a 2-year period on August 9, 2008, with which it received a 4.00% fixed rate and paid LIBOR plus 1.20% on a notional amount of USD 6.5 million. Payments were to be made every 6 months. The table below displays the actual annual 6-month LIBOR rates over the 2-year period.

| Date | 6-month LIBOR |
|---|---|
| Aug 9, | 3.11% |
| Feb 9, | 1.76% |
| Aug 9, | 0.84% |
| Feb 9, | 0.39% |
| Aug 9, | 0.58% |

Assuming no default, how much did Savers Bancorp receive on August 9, 2010?

**a.** USD 72,150
**b.** USD 78,325
**c.** USD 117,325
**d.** USD 156,650

Correct answer: b

Explanation: The proper interest rate to use is the 6-month LIBOR rate at February 9, 2010, since it is the 6-month LIBOR that will yield the payoff on August 9, 2010. Therefore the net settlement amount on August 9th, 2010 is as follows:
Savers receives: 6,500,000 * 4.00% * 0.5 years, or USD 130,000
Savers pays 6,500,000 * (0.39% + 1.20%) * 0.5, or USD 51,675.
Therefore Savers would receive the difference, or 78,325.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson 2014), Chapter 7 - Swaps
**Learning Objective**: Explain the mechanics of a plain vanilla interest rate swap and compute its cash flows.

**35.** The six-month forward price of commodity X is USD 1,000. Six-month, risk-free, zero-coupon bonds with face value USD 1,000 trade in the fixed income market. When taken in the correct amounts, which of the following strategies creates a synthetic long position in commodity X for a period of 6 months?

**a.** Short the forward contract and short the zero-coupon bond.
**b.** Short the forward contract and buy the zero-coupon bond.
**c.** Buy the forward contract and short the zero-coupon bond.
**d.** Buy the forward contract and buy the zero-coupon bond.

Correct answer: d

Explanation: A synthetic commodity position for a period of T years can be constructed by entering into a long forward contract with T years to expiration and buying a zero-coupon bond expiring in T years with a face value of the forward price. The payoff function is as follows:

Payoff from long forward position = $S_T - F_{0,T}$ , where $S_T$ is the spot price of the commodity at time T and $F_{0,T}$ is the current forward price.
Payoff from zero coupon bond: $F_{0,T}$ at time T.
Hence, the total payoff function equals $(S_T - F_{0,T}) + F_{0,T}$ or $S_T$. This creates a synthetic commodity position.

**Section**: Financial Markets and Products
**Reference**: Robert McDonald, *Derivatives Markets, 3rd Edition* (Boston: Pearson, 2012). Chapter 6 – Commodity Forwards and Futures
**Learning Objective**: Explain how to create a synthetic commodity position, and use it to explain the relationship between the forward price and the expected future spot price.

**36.** Bank A and Bank B are two competing investment banks that are calculating the 1-day 99% VaR for an at-the-money call on a non-dividend-paying stock with the following information:

- Current stock price: USD 120
- Estimated annual stock return volatility: 18%
- Current Black-Scholes-Merton option value: USD 5.20
- Option delta: 0.6

To compute VaR, Bank A uses the linear approximation method, while Bank B uses a Monte Carlo simulation method for full revaluation. Which bank will estimate a higher value for the 1-day 99% VaR?

**a.** Bank A.
**b.** Bank B.
**c.** Both will have the same VaR estimate.
**d.** Insufficient information to determine.

Correct answer: a

Explanation: The option's return function is convex with respect to the value of the underlying; therefore the linear approximation method will always underestimate the true value of the option for any potential change in price. Therefore the VaR will always be higher under the linear approximation method than a full revaluation conducted by Monte Carlo simulation analysis. The difference is the bias resulting from the linear approximation, and this bias increases in size with the change in the option price and with the holding period.

**Section**: Valuation and Risk Models
**Reference**: Linda Allen, Jacob Boudoukh and Anthony Saunders, *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (New York: Wiley-Blackwell, 2004). Chapter 3 – Putting VaR to Work
**Learning Objective**: Compare delta-normal and full revaluation approaches for computing VaR.

**37.** In evaluating the dynamic delta hedging of a portfolio of short option positions, which of the following is correct?

**a.** The interest cost of carrying the delta hedge will be highest when the options are deep out-of-the-money.
**b.** The interest cost of carrying the delta hedge will be highest when the options are deep in-the-money.
**c.** The interest cost of carrying the delta hedge will be lowest when the options are at-the-money.
**d.** The interest cost of carrying the delta hedge will be highest when the options are at-the-money.

Correct answer: b

Explanation: The deeper into-the-money the options are, the larger their deltas and therefore the more expensive to delta hedge.

**Section**: Valuation and Risk Models
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson Prentice Hall, 2014), Chapter19 – Greek Letters
**Learning Objective**: Describe the dynamic aspects of delta hedging and distinguish between dynamic hedging and hedge-and-forget strategy.

**QUESTIONS 38 AND 39 REFER TO THE FOLLOWING INFORMATION**

A risk manager is evaluating the price sensitivity of an investment-grade callable bond using the firm's valuation system. The table below presents information on the bond as well as on the embedded option. The current interest rate environment is flat at 5%.

Value in USD per USD 100 face value

| Interest Rate Level | Callable Bond | Call Option |
|---|---|---|
| 4.98% | 102.07848 | 2.0871 |
| 5.00% | 101.61158 | 2.05010 |
| 5.02% | 100.92189 | 2.0131 |

**38.** The DV01 of a comparable bond with no embedded options having the same maturity and coupon rate is closest to:

- **a.** 0.0185
- **b.** 0.2706
- **c.** 0.2891
- **d.** 0.3077

Correct answer: d

Explanation: The call option reduces the bond price, therefore the bond with no embedded options will be the sum of the callable bond price and the call option price.
Therefore the price of the bond with no embedded options at a rate of 4.98% would be 104.1657 and the price at a rate of 5.02% would be 102.9351.

DV01 is a measure of price sensitivity of a bond. To calculate the DV01, the following equation is used:

$$\text{DV01} = -\frac{\Delta P}{10{,}000 * \Delta y}$$

Where ΔP is the change in price and Δy is the change in yield. Therefore

$$\text{DV01} = -\frac{102.9351 - 104.1657}{10{,}000 * (5.02\% - 4.98\%)} = 0.3077$$

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken: John Wiley and Sons, 2011), Chapter 4 – One-Factor Risk Metrics and Hedges
**Learning Objective**: Define and compute the DV01 of a fixed income security given a change in yield and the resulting change in price.

SEE INFORMATION PRECEDING QUESTION 39

A risk manager is evaluating the price sensitivity of an investment-grade callable bond using the firm's valuation system. The table below presents information on the bond as well as on the embedded option. The current interest rate environment is flat at 5%.

Value in USD per USD 100 face value

| Interest Rate Level | Callable Bond | Call Option |
|---|---|---|
| 4.98% | 102.07848 | 2.0871 |
| 5.00% | | 2.0501 |
| 5.02% | 100.92189 | |

**39.** The convexity of the callable bond can be estimated as:

**a.** -55,698
**b.** -54,814
**c.** -5.5698
**d.** -5.4814

Correct answer: b

Explanation: Convexity is defined as the second derivative of the price-rate function divided by the price of the bond. To estimate convexity, one must first estimate the difference in bond price per difference in the rate for two separate rate environments, one a step higher than the current rate and one a step lower. One must then estimate the change across these two values per difference in rate. This is given by the formula:

$$C = \frac{1}{P_0} * \frac{\frac{P_1 - P_0}{\Delta r} - \frac{P_0 - P_{-1}}{\Delta r}}{\Delta r} = \frac{1}{P_0} * \frac{P_1 - 2P_0 + P_{-1}}{\Delta r^2}$$

where Δr is the change in the rate in one step; in this case, 0.02%.

Therefore, the best estimate of convexity is:

$$C = \frac{1}{101.61158} * \frac{100.92189 - (2 * 101.61158) + 102.07848}{(0.02\%)^2} = -54{,}814$$

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken: John Wiley and Sons, 2011), Chapter 4 – One-Factor Risk Metrics and Hedges
**Learning Objective**: Define, compute, and interpret the convexity of a fixed income security given a change in yield and the resulting change in price.

**40.** A portfolio contains a long position in an option contract on a US Treasury bond. The option exhibits positive convexity across the entire range of potential returns for the underlying bond. This positive convexity:

**a.** Implies that the option's value increases at a decreasing rate as the option goes further into the money.
**b.** Makes a long option position a superior investment compared to a long bond position of equivalent duration.
**c.** Can be effectively hedged by the sale of a negatively convex financial instrument.
**d.** Implies that the option increases in value as market volatility increases.

Correct answer: d

Explanation: The relationship between convexity and volatility for a security can be seen most clearly through the second-order Taylor approximation of the change in price given a small change in yield. The resulting change in price can be estimated as:

$$\frac{\Delta P}{P} \approx -D\Delta y + \frac{1}{2}C\Delta y^2$$

where d is equal to the duration, c is the convexity and y is the change in the interest rate. Since $\Delta y$ is always positive, positive convexity will lead to an increase in return as long as interest rates move, with larger interest moves in either direction leading to a greater return benefit from the positive convexity. Therefore, a position in a security with positive convexity can be considered a long position in volatility.

This relationship can also be explained graphically. The price curve of a security with positive convexity will lie above and tangentially to the price curve of the underlying. If volatility of the underlying increases, then so will the volatility of either a long call or a long put, but the deviation from the price of the underlying will be positive when there is positive convexity, and negative with negative convexity. Therefore, the expected terminal value over the in-the-money region will increase while the expected terminal value over the out-of-the-money region will remain zero, an aggregate effect of increasing the total expected value of the option.

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken: John Wiley and Sons, 2011), Chapter 4 – One-Factor Risk Metrics and Hedges
**Learning Objective**: Define, compute, and interpret the convexity of a fixed income security given a change in yield and the resulting change in price.

**41.** An implementation principle recommended by the Basel Committee to banks for the governance of sound stress testing practices is that stress testing reports should:

**a.** Not be passed up to senior management without first being approved by middle management.
**b.** Have limited input from their respective business areas to prevent biasing of the results.
**c.** Challenge prior assumptions to help foster debate among decision makers.
**d.** Be separated by business lines to help identify risk concentrations.

Correct answer: c

Explanation: The Basel Committee states "At banks that were highly exposed to the financial crisis and fared comparatively well, senior management as a whole took an active interest in the development and operation of stress testing… stress testing at most banks, however, did not foster internal debate nor challenge prior assumptions…" Therefore, the Basel Committee recommends that prior assumptions used in stress testing be challenged to ensure that the stress test best captures the potential for extreme scenarios given current market conditions.

**Section**: Valuation and Risk Models
**Reference**: Basel Committee on Banking Supervision Publication (2009), *Principles for Sound Stress Testing*
*Practices and Supervision*.
**Learning Objective**: Describe weaknesses identified and recommendations for improvement in: The use of stress testing and integration in risk governance.

**42.** A risk manager performs an ordinary least squares (OLS) regression to estimate the sensitivity of a stock's return to the return on the S&P 500. This OLS procedure is designed to:

**a.** Minimize the square of the sum of differences between the actual and estimated S&P 500 returns.
**b.** Minimize the square of the sum of differences between the actual and estimated stock returns.
**c.** Minimize the sum of differences between the actual and estimated squared S&P 500 returns.
**d.** Minimize the sum of squared differences between the actual and estimated stock returns.

Correct Answer: d

Rationale: The OLS procedure is a method for estimating the unknown parameters in a linear regression model. The method minimizes the sum of squared differences between the actual, observed, returns and the returns estimated by the linear approximation. The smaller the sum of the squared differences between observed and estimated values, the better the estimated regression line fits the observed data points.

**Section**: Quantitative Analysis
**Reference**: James Stock and Mark Watson, *Introduction to Econometrics, Brief Edition* (Boston: Pearson Education, 2008). Chapter 4 - Linear Regression with One Regressor
**Learning Objective**: Define an ordinary least squares (OLS) regression and calculate the intercept and slope of the regression.

**43.** Using the prior 12 monthly returns, an analyst estimates the mean monthly return of stock XYZ to be -0.75% with a standard error of 2.70%.

| ONE-TAILED T-DISTRIBUTION TABLE | | | |
|---|---|---|---|
| Degrees of Freedom | α | | |
| | 0.10 | 0.05 | 0.025 |
| 8 | 1.39 | 1.86 | 2.306 |
| 9 | 1.38 | 1.83 | 2.262 |
| 10 | 1.37 | 1.81 | 2.228 |
| 11 | 1.36 | 1.79 | 2.201 |
| 12 | 1.35 | 1.78 | 2.179 |

Using the t-table above, the 95% confidence interval for the mean return is between:

**a.** -6.69% and 5.19%
**b.** -6.63% and 5.15%
**c.** -5.60% and 4.10%
**d.** -5.56% and 4.06%

Correct Answer: a

Rationale: The confidence interval is equal to the mean monthly return plus or minus the t-statistic times the standard error. To get the proper t-statistic, the 0.025 column must be used since this is a two-tailed interval. Since the mean return is being estimated using the sample observations, the appropriate degrees of freedom to use is equal to the number of sample observations minus 1. Therefore we must use 11 degrees of freedom and therefore the proper statistic to use from the t-distribution is 2.201.

The proper confidence interval is: -0.75% +/- (2.201 * 2.70%) or -6.69% to +5.19%.

**Section**: Quantitative Analysis
**Reference**: *Michael Miller, Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013). Chapter 7 - Hypothesis Testing and Confidence Intervals
**Learning Objective**: Construct and interpret a confidence interval.

**44.** Using data from a pool of mortgage borrowers, a credit risk analyst performed an ordinary least squares regression of annual savings (in GBP) against annual household income (in GBP) and obtained the following relationship:

Annual Savings = 0.24 * Household Income - 25.66, $R^2 = 0.50$

Assuming that all coefficients are statistically significant, which interpretation of this result is correct?

**a.** For this sample data, the average error term is GBP -25.66.
**b.** For a household with no income, annual savings is GBP 0.
**c.** For an increase of GBP 1,000 in income, expected annual savings will increase by GBP 240.
**d.** For a decrease of GBP 2,000 in income, expected annual savings will increase by GBP 480.

Correct Answer: c

Rationale: An estimated coefficient of 0.24 from a linear regression indicates a positive relationship between income and savings, and more specifically means that a one unit increase in the independent variable (household income) implies a 0.24 unit increase in the dependent variable (annual savings). Given the equation provided, a household with no income would be expected to have negative annual savings of GBP 25.66. The error term mean is assumed to be equal to 0.

**Section**: Quantitative Analysis
**Reference**: James Stock and Mark Watson, *Introduction to Econometrics, Brief Edition* (Boston: Pearson Education, 2008), Chapter 4 - Linear Regression with One Regressor
**Learning Objective**: Interpret a population regression function, regression coefficients, parameters, slope, intercept, and the error term.

**45.** A risk analyst is estimating the variance of stock returns on day n, given by $\sigma_n^2$, using the equation $\sigma_n^2 = \gamma V_L + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2$ where $u_{n-1}$ and $\sigma_{n-1}$ represent the return and volatility on day n-1, respectively. If the values of α and β are as indicated below, which combination of values indicates that the variance follows a stable GARCH (1,1) process?

**a.** α = 0.084427 and β = 0.909073
**b.** α = 0.084427 and β = 0.925573
**c.** α = 0.085427 and β = 0.925573
**d.** α = 0.090927 and β = 0.925573

Correct Answer: a

Rationale: For a GARCH (1,1) process to be stable, the sum of parameters α and β need to be below 1.0.

**Section**: Quantitative Analysis
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 23 - Estimating Volatilities and Correlations for Risk Management
**Learning Objective**: Describe the generalized autoregressive conditional heteroskedasticity (GARCH(p,q)) model for estimating volatility and its properties:
Calculate volatility using the GARCH (1,1) model
Explain mean reversion and how it is captured in the GARCH (1,1) model

**The following information applies to questions 46 and 47**

A portfolio manager holds three bonds in one of the portfolios and each bond has a 1-year default probability of 15%. The event of default for each of the bonds is independent.

**46.** What is the probability of exactly two bonds defaulting over the next year?

**a.** 1.9%
**b.** 5.7%
**c.** 10.8%
**d.** 32.5%

Correct Answer: b

Rationale: Since the bond defaults are independent and identically distributed Bernoulli random variables, the Binomial distribution can be used to calculate the probability of exactly two bonds defaulting.

The correct formula to use is $\frac{n!}{k!(n-k)!} \times p^k \times (1-p)^{n-k}$

Where n = the number of bonds in the portfolio, p = the probability of default of each individual bond, and k = the number of defaults for which you would like to find the probability. In this case n = 3, p = 0.15, and k = 2.

Entering the variables into the equation, this simplifies to 3 x 0.152 x 0.85 = .0574.

**Section**: Quantitative Analysis
**Reference**: Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013). Chapter 4 - Distributions
**Learning Objective**: Distinguish the key properties among the following distributions: uniform distribution, Bernoulli distribution, Binomial distribution, Poisson distribution, normal distribution, lognormal distribution, Chi-squared distribution, Student's t, and F-distributions, and identify common occurrences of each distribution.

**47.** What is the mean and variance of the number of bonds defaulting over the next year?

**a.** Mean = 0.15, variance = 0.32
**b.** Mean = 0.45, variance = 0.38
**c.** Mean = 0.45, variance = 0.32
**d.** Mean = 0.15, variance = 0.38

Correct Answer: b

Rationale: Letting n equal the number of bonds in the portfolio and p equal the individual default probability, the formulas to use are as follows:

Mean = n x p = 3 x 15% = 0.45. Variance = n x p x (1-p) = 3 x .15 x .85 = 0.3825

**Section**: Quantitative Analysis
**Reference**: Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 4 - Distributions
**Learning Objective**: Distinguish the key properties among the following distributions: uniform distribution, Bernoulli distribution, Binomial distribution, Poisson distribution, normal distribution, lognormal distribution, Chi-squared distribution, Student's t, and F-distributions, and identify common occurrences of each distribution.

**48.** An investment advisor is analyzing the range of potential expected returns of a new fund designed to replicate the directional moves of the BSE Sensex Index but with twice the volatility of the index. The Sensex has an expected annual return of 12.3% and volatility of 19.0%, and the risk free rate is 2.5% per year. Assuming the correlation between the fund's returns and that of the index is 1, what is the expected return of the fund using the capital asset pricing model?

**a.** 18.5%
**b.** 19.0%
**c.** 22.1%
**d.** 24.6%

Correct Answer: c

Rationale: If the CAPM holds, then $R_i = R_f + \beta_i \times (R_m - R_f)$, which is maximized at the greatest possible beta value which implies a correlation of 1 between the fund's return and the index return. Since the volatility of the fund is twice that of the index, a correlation of 1 implies a maximum beta $\beta_i$ of 2. Therefore: $R_i$ (max) = 2.5% + 2 x (12.3% - 2.5%) = 22.1%.

**Section**: Foundations of Risk Management
**Reference**: Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann, *Modern Portfolio Theory and Investment Analysis, 9th Edition* (Hoboken, NJ: John Wiley & Sons, 2014). Chapter 13 - The Standard Capital Asset Pricing Model
**Learning Objective**: Apply the CAPM in calculating the expected return on an asset.

**49.** A risk analyst is reconciling customer account data held in two separate databases and wants to ensure the account number for each customer is the same in each database. Which dimension of data quality would she be most concerned with in making this comparison?

**a.** Completeness
**b.** Accuracy
**c.** Consistency
**d.** Currency

Correct Answer: c

Rationale: Consistency refers to the comparison of one element of data across two or more different databases.

**Section**: Foundations of Risk Management
**Reference**: Anthony Tarantino and Deborah Cernauskas, *Risk Management in Finance: Six Sigma and Other Next Generation Techniques* (Hoboken, NJ: John Wiley & Sons, 2009). Chapter 3 - Information Risk and Data Quality Management
**Learning Objective**: Explain how a firm can set expectations for its data quality and describe some key dimensions of data quality used in this process.

**50.** The hybrid approach for estimating VaR is the combination of a parametric and a nonparametric approach. It specifically combines the historical simulation approach with:

**a.** The delta normal approach.
**b.** The exponentially weighted moving average approach.
**c.** The multivariate density estimation approach.
**d.** The generalized autoregressive conditional heteroskedasticity approach.

Correct Answer: b

Rationale: The hybrid approach combines two approaches to estimating VaR, the historical simulation and the exponential smoothing approach (i.e. an EWMA approach). Similar to a historical simulation approach, the hybrid approach estimates the percentiles of the return directly, but it also uses exponentially declining weights on past data similar to the exponentially weighted moving average approach.

**Section**: Valuation and Risk Models
**Reference**: Linda Allen, Jacob Boudoukh and Anthony Saunders, *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (New York: Wiley-Blackwell, 2004), Chapter 2 - Quantifying Volatility in VaR Models
**Learning Objective**: Compare and contrast different parametric and non-parametric approaches for estimating conditional volatility.

**51.** A non-dividend-paying stock is currently trading at USD 40 and has an expected return of 12% per year. Using the Black-Scholes-Merton (BSM) model, a 1-year, European-style call option on the stock is valued at USD 1.78. The parameters used in the model are:

$N(d_1) = 0.29123$ $N(d_2) = 0.20333$

The next day, the company announces that it will pay a dividend of USD 0.5 per share to holders of the stock on an ex-dividend date 1 month from now and has no further dividend payout plans for at least 1 year. This new information does not affect the current stock price, but the BSM model inputs change, so that:

$N(d_1) = 0.29928$ $N(d_2) = 0.20333$

If the risk-free rate is 3% per year, what is the new BSM call price?

**a.** USD 1.61
**b.** USD 1.78
**c.** USD 1.95
**d.** USD 2.11

Correct Answer: c

Rationale: The value of a European call is equal to $S * N(d_1) - Ke^{-rT} * N(d_2)$, where S is the current price of the stock. In the case that dividends are introduced, S in the formula is reduced by the present value of the dividends.

Furthermore, the announcement would affect the values of S, $d_1$ and $d_2$. However, since we are given the new values, and $d_2$ is the same, the change in the price of the call is only dependent on the term $S * N(d_1)$.

Previous $S * N(d_1) = 40 * 0.29123 = 11.6492$

New $S * N(d_1) = (40 - (0.5 * \exp(-3\%/12)) * 0.29928 = 11.8219$

Change = 11.8219 – 11.6492 = 0.1727

So the new BSM call price would increase in value by 0.1727, which when added to the previous price of 1.78 equals 1.9527.

**Section**: Valuation and Risk Models
**Reference**: John Hull, Options, *Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 15 - The Black-Scholes-Merton Model
**Learning Objective**: Compute the value of a European option using the Black-Scholes-Merton model on a dividend-paying stock.

**52.** An at-the-money European call option on the DJ EURO STOXX 50 index with a strike of 2200 and maturing in 1 year is trading at EUR 350, where contract value is determined by EUR 10 per index point. The risk-free rate is 3% per year, and the daily volatility of the index is 2.05%. If we assume that the expected return on the DJ EURO STOXX 50 is 0%, the 99% 1-day VaR of a short position on a single call option calculated using the delta-normal approach is closest to:

- **a.** EUR 8.
- **b.** EUR 53.
- **c.** EUR 84.
- **d.** EUR 525.

Correct Answer: d

Rationale: Since the option is at-the-money, the delta is close to 0.5. Therefore a 1 point change in the index would translate to approximately 0.5 * EUR 10 = EUR 5 change in the call value.

Therefore, the percent delta, also known as the local delta, defined as %D = (5/350) / (1/2200) = 31.4.

So the 99% VaR of the call option = %D * VaR(99% of index) = %D * call price * alpha (99%) * 1-day volatility = 31.4 * EUR 350 * 2.33 * 2.05% = EUR 525. The term alpha (99%) denotes the 99th percentile of a standard normal distribution, which equals 2.33.

There is a second way to compute the VaR. If we just use a conversion factor of EUR 10 on the index, then we can use the standard delta, instead of the percent delta:

VaR(99% of Call) = D * index price * conversion * alpha (99%) * 1-day volatility = 0.5 * 2200 * 10 * 2.33 * 2.05% = EUR 525, with some slight difference in rounding.

Both methods yield the same result.

**Section**: Valuation and Risk Models
**Reference**: Linda Allen, Jacob Boudoukh and Anthony Saunders, *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (New York: Wiley-Blackwell, 2004), Chapter 3 - Putting VaR to Work
**Learning Objective**: Compare delta-normal and full revaluation approaches for computing VaR.

**53.** The current stock price of a company is USD 80. A risk manager is monitoring call and put options on the stock with exercise prices of USD 50 and 5 days to maturity. Which of these scenarios is most likely to occur if the stock price falls by USD 1?

| Scenario | Call Value | Put Value |
|---|---|---|
| A | Decrease by | Increase by USD |
| B | Decrease by | Increase by USD |
| C | Decrease by | Increase by USD |
| D | Decrease by | Increase by USD |

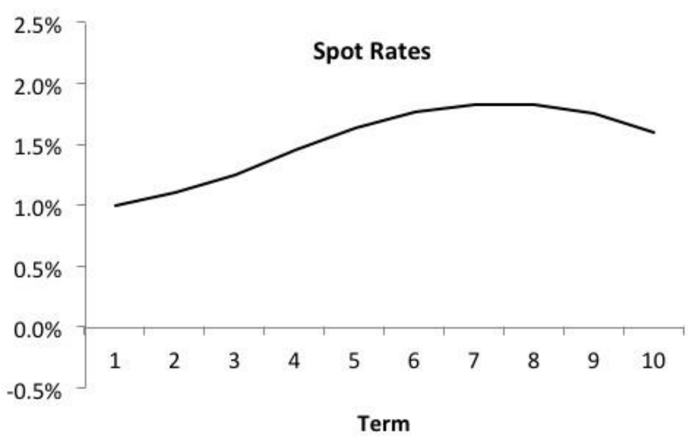
**a.** Scenario A
**b.** Scenario B
**c.** Scenario C
**d.** Scenario D

Correct Answer: a

Rationale: The call option is deep in-the-money and must have a delta close to one. The put option is deep out-of- the-money and will have a delta close to zero. Therefore, the value of the in-the-money call will decrease by close to USD 1, and the value of the out-of-the-money put will increase by a much smaller amount close to 0. The choice that is closest to satisfying both conditions is A.

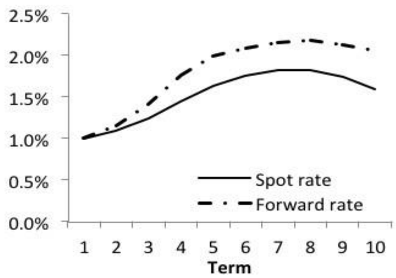
**Section**: Valuation and Risk Models
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 19 -The Greek Letters
**Learning Objective**: Describe the dynamic aspects of delta hedging and distinguish between dynamic hedging and hedge-and-forget strategy.

**54.** Below is a chart showing the term structure of risk-free spot rates:

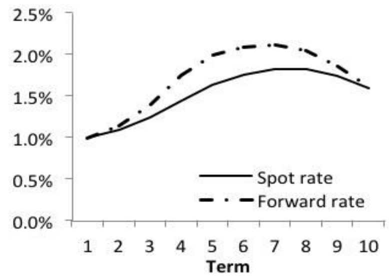


Which of the following charts presents the correct derived forward rate curve?

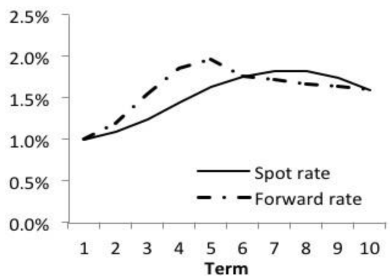
**a.**



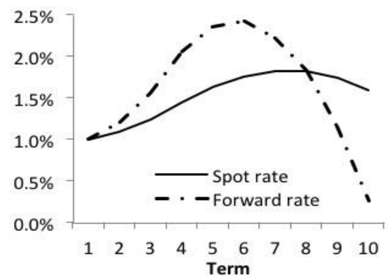

**b.**




**c.**




**d.**




Correct Answer: d

Rationale: The forward curve will be above the spot curve when the spot curve is rising. The forward curve will also cross the spot curve when the spot curve reaches its maximum (or extreme) value. The forward curve will be below the spot curve when the spot curve is declining. The only chart that reflects these three conditions is choice D.

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: John Wiley & Sons, 2001), Chapter 2 - Spot, Forward, and Par Rates
**Learning Objective**: Interpret the forward rate, and compute forward rates given spot rates.

**55.** A hedge fund manager wants to change the fund's interest rate exposure by investing in fixed-income securities with negative duration. Which of the following securities should the fund manager buy?

**a.** Short maturity calls on zero-coupon bonds with long maturity
**b.** Short maturity puts on interest-only strips from long maturity conforming mortgages
**c.** Short maturity puts on zero-coupon bonds with long maturity
**d.** Short maturity calls on principal-only strips from long maturity conforming mortgages

Correct Answer: c

Rationale: In order to change her interest rate exposure by acquiring securities with negative duration, the manager will need to invest in securities that decrease in value as interest rates fall (and increase in value as interest rates rise). Zero coupon bonds with long maturity will increase in value as interest rates fall, so calls on these bonds will increase in value as rates fall but puts on these bonds will decrease in value and this makes C the correct choice. Interest-only strips from long maturity conforming mortgages will decrease in value as interest rates fall, so puts on them will increase in value, while principal strips on these same mortgages will increase in value, so calls on them will also increase in value.

**Section**: Valuation and Risk Models
**Reference**: Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: John Wiley & Sons), Chapter 4 - One-Factor Risk Metrics and Hedges
**Learning Objective**: Define, compute and interpret the effective duration of a fixed income security given a change in yield and the resulting change in price.

**56.** A trader writes the following 1-year European-style barrier options as protection against large movements in a non-dividend paying stock that is currently trading at EUR 40.96.

| Option | Price |
|---|---|
| Up-and-in barrier call, with barrier at EUR 45 | 3.52 |
| Up-and-out barrier call, with barrier at EUR 45 | 1.24 |
| Down-and-in barrier put, with barrier at EUR 35 | 2.00 |
| Down-and-out barrier put, with barrier at EUR 35 | 1.01 |

All of the options have the same strike price. Assuming the risk-free rate is 2% per annum, what is the common strike price of these options?

**a.** EUR 39.00
**b.** EUR 40.00
**c.** EUR 41.00
**d.** EUR 42.00

Correct Answer: b

Rationale: The sum of the price of an up-and-in barrier call and an up-and-out barrier call is the price of an other- wise equivalent European call. The price of the European call is EUR 3.52 + EUR 1.24 = EUR 4.76.

The sum of the price of a down-and-in barrier put and a down-and-out barrier put is the price of an otherwise equivalent European put. The price of the European put is EUR 2.00 + EUR 1.01 = EUR 3.01. Using put-call parity, where C represents the price of a call option and P the price of a put option,

$C + Ke^{-rt} = P + S$

$K = e^{rt} (P + S - C)$

Hence, $K = e^{0.02*1} * (3.01 + 40.96 - 4.76) = 40.00$

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 26 - Exotic Options
**Learning Objective**: Identify and describe the characteristics and pay-off structure of the following exotic options: Chooser and barrier options

**57.** A fixed-income portfolio manager purchases a seasoned 5.5% agency mortgage-backed security with a weighted average loan age of 60 months. The current balance on the loans is USD 20 million, and the conditional prepayment rate is assumed to be constant at 0.4% per year. Which of the following is closest to the expected principal prepayment this month?

**a.** USD 1,000
**b.** USD 7,000
**c.** USD 10,000
**d.** USD 70,000

Correct Answer: b

Rationale: The expected principal prepayment is equal to: 20,000,000 * (1-((1-0.004)^(1/12))) = USD 6,679.

**Section**: Financial Markets and Products
**Reference**: Bruce Tuckman, Angel Serrat, *Fixed Income Securities: Tools for Today's Markets, 3rd Edition*, (Hoboken, NJ: John Wiley & Sons, 2011), Chapter 20 - Mortgages and Mortgage-Backed Securities
**Learning Objective**: Calculate a fixed rate mortgage payment, and its principal and interest components. Describe the mortgage prepayment option and the factors that influence prepayments.

**58.** The rating agencies have analyzed the creditworthiness of Company XYZ and have determined that the company currently has adequate payment capacity, although a negative change in the business environment could affect its capacity for repayment. The company has been given an investment grade rating by S&P and Moody's. Which of the following S&P/Moody's ratings has Company XYZ been assigned?

**a.** AA/Aa
**b.** A/A
**c.** BBB/Baa
**d.** BB/Ba

Correct Answer: c

Rationale: The interpretation given by the above statement refers to a rating of BBB/Baa, which is a lower invest- ment grade rating. A rating of BB/Ba is not investment grade, an AA/Aa rating is a very high investment grade rating and an A/A rating still reflects a strong capacity to make payments.

**Section**: Financial Markets and Products
**Reference**: John Caouette, Edward Altman, Paul Narayanan and Robert Nimmo, *Managing Credit Risk: The Great Challenge for Global Financial Markets, 2nd Edition* (New York: John Wiley & Sons, 2008), Chapter 6 - The Rating Agencies
**Learning Objectives**: Describe Standard and Poor's and Moody's rating scales and distinguish between investment and noninvestment grade ratings. Describe a rating scale, define credit outlooks, and explain the difference between solicited and unsolicited ratings.

**59.** A French bank enters into a 6-month forward contract with an importer to sell GBP 40 million in 6 months at a rate of EUR 0.80 per GBP. If in 6 months the exchange rate is EUR 0.85 per GBP, what is the payoff for the bank from the forward contract?

- **a.** EUR -2,941,176
- **b.** EUR -2,000,000
- **c.** EUR 2,000,000
- **d.** EUR 2,941,176

Correct Answer: b

Rationale: The value of the contract for the bank at expiration: 40,000,000 GBP * 0.80 EUR/GBP The cost to close out the contract for the bank at expiration: 40,000,000 GBP * 0.85 EUR/GBP
Therefore, the final payoff in EUR to the bank can be calculated as: 40,000,000*(0.80 – 0.85) = -2,000,000 EUR.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 1 – Introduction
**Learning Objective**: Calculate and compare the payoffs from hedging strategies involving forward contracts and options.

**60.** An oil driller recently issued USD 250 million of fixed-rate debt at 4.0% per annum to help fund a new project. It now wants to convert this debt to a floating-rate obligation using a swap. A swap desk analyst for a large investment bank that is a market maker in swaps has identified four firms interested in swapping their debt from floating-rate to fixed-rate. The following table quotes available loan rates for the oil driller and each firm:

| Firm | Fixed-rate (in %) | Floating-rate (in %) |
|---|---|---|
| Oil | 4.0 | 6-month LIBOR + |
| Firm A | 3.5 | 6-month LIBOR + |
| Firm B | 6.0 | 6-month LIBOR + |
| Firm C | 5.5 | 6-month LIBOR + |
| Firm D | 4.5 | 6-month LIBOR + |

A swap between the oil driller and which firm offers the greatest possible combined benefit?

**a.** Firm A
**b.** Firm B
**c.** Firm C
**d.** Firm D

Correct Answer: c

Rationale: Since the oil driller is swapping out of a fixed-rate and into a floating-rate, the larger the difference between the fixed spread and the floating spread the greater the combined benefit. See table below:

| Firm | Fixed-rate | Floating-rate | Fixed-spread | Floating-spread | Possible Benefit |
|---|---|---|---|---|---|
| Oil | 4.0 | 1.5 | | | |
| Firm A | 3.5 | 1.0 | -0.5 | -0.5 | -0.0 |
| Firm B | 6.0 | 3.0 | 2.0 | 1.5 | 0.5 |
| Firm C | 5.5 | 2.0 | 1.5 | 0.5 | 1.0 |
| Firm D | 4.5 | 2.5 | 0.5 | 1.0 | -0.5 |

**Section**: Financial Markets and Products
**Reference**: John Hull, Options, *Futures and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 7 - Swaps
**Learning Objective**: Describe the comparative advantage argument for the existence of interest rate swaps and evaluate some of the criticisms of this argument.

**61.** Consider an American call option and an American put option, each with 3 months to maturity, written on a non-dividend-paying stock currently priced at USD 40. The strike price for both options is USD 35 and the risk-free rate is 1.5%. What are the lower and upper bounds on the difference between the prices of the call and put options?

| Sce | Lower Bound | Upper Bound |
|---|---|---|
| A | 5.13 | 40.00 |
| B | 5.00 | 5.13 |
| C | 34.87 | 40.00 |
| D | 0.13 | 34.87 |

**a.** Scenario A
**b.** Scenario B
**c.** Scenario C
**d.** Scenario D

Correct Answer: b

Rationale: The put-call parity in case of American options leads to the inequality:
$S_0 - X \le (C - P) \le S_0 - Xe^{-rT}$
The lower and upper bounds are given by—
$= 40 - 35 \le (C - P) \le 40 - 35e^{-0.015 \times 3/12}$
$= 5 \le (C - P) \le 5.13$

Alternatively, the upper and lower bounds for American options are given by

| Option | Minimum Value | Maximum |
|---|---|---|
| American | $c \ge \max(0, S_0 - Xe^{-rT}) = 5.13$ | $S_0 = 40$ |
| American | $p \ge \max(0, X - S_0) = 0$ | $X = 35$ |

Subtracting the put values from the call values in the table above, we get the same result—
$= 5 \le C - P \le 5.13$

(Note- the minimum and maximum values are obtained by comparing the results of the subtraction of the put price from the call price. For instance, in this example, the upper bound is obtained by subtracting the minimum value of the American put option from the minimum value of the American call option and vice versa).

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 11 - Properties of Stock Options
**Learning Objective**: Identify and compute upper and lower bounds for option prices on non-dividend and dividend paying stocks. Explain put-call parity and apply it to the valuation of European and American stock options.

**62.** A German housing corporation needs to hedge against rising interest rates. It has chosen to use futures on 10-year German government bonds. Which position in the futures should the corporation take, and why?

- **a.** Take a long position in the futures because rising interest rates lead to rising futures prices.
- **b.** Take a short position in the futures because rising interest rates lead to rising futures prices.
- **c.** Take a short position in the futures because rising interest rates lead to declining futures prices.
- **d.** Take a long position in the futures because rising interest rates lead to declining futures prices.

Correct Answer: c

Rationale: Government bond futures decline in value when interest rates rise, so the housing corporation should short futures to hedge against rising interest rates.

**Section**: Financial Markets and Products
**Reference**: John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 3 - Hedging Strategies Using Futures
**Learning Objective**: Define and differentiate between short and long hedges and identify their appropriate uses.

**63.** Barings was forced to declare bankruptcy after reporting over USD 1 billion in unauthorized trading losses by a single trader, Nick Leeson. Which of the following statements concerning the collapse of Barings is correct?

- **a.** Leeson avoided reporting the unauthorized trades by convincing the head of his back office that they did not need to be reported.
- **b.** Management failed to investigate high levels of reported profits even though they were associated with a low-risk trading strategy.
- **c.** Leeson traded primarily in OTC foreign currency swaps which allowed Barings to delay cash payments on losing trades until the first payment was due.
- **d.** The loss at Barings was detected when several customers complained of losses on trades that were booked to their accounts.

Correct Answer: b

Rationale: Leeson was supposed to be running a low-risk, limited return arbitrage business out of his Singapore office, but in actuality he was investing in large speculative positions in Japanese stocks and interest rate futures and options. When Leeson fraudulently declared very substantial reported profits on his positions, management did not investigate the stream of large profits even thought it was supposed to be associated with a low-risk strategy.

**Section**: Foundations of Risk Management
**Reference**: Steve Allen, *Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk, 2nd Edition* (New York: John Wiley & Sons, 2013), Chapter 4 - Financial Disasters
**Learning Objective**: Analyze the key factors that led to and derive the lessons learned from the following risk management case studies: Barings.

**64.** For a sample of the past 30 monthly stock returns for McCreary, Inc., the mean return is 4% and the sample standard deviation is 20%. Since the population variance is unknown, the standard error of the sample is estimated to be:

$$S_x = \frac{20\%}{\sqrt{30}} = 3.65\%$$

The related t-table values are ($t_{i,j}$ denotes the (100-$j$)$^{th}$ percentile of $t$-distribution value with $i$ degrees of freedom):

| | |
|---|---|
| $t_{29,2.5}$ | 2.045 |
| $t_{29,5.0}$ | 1.699 |
| $t_{30,2.5}$ | 2.042 |
| $t_{30,5.0}$ | 1.697 |

What is the 95% confidence interval for the mean monthly return?

**a.** [-3.453%, 11.453%]
**b.** [-2.201%, 10.201%]
**c.** [-2.194%, 10.194%]
**d.** [-3.467%, 11.467%]

Answer: D

Explanation: Here the $t$-reliability factor is used since the population variance is unknown. Since there are 30 observations, the degrees of freedom are 30 - 1 = 29. The $t$-test is a two-tailed test. So the correct critical $t$-value is $t_{29,2.5}$ = 2.045, thus the 95% confidence interval for the mean return is:

$$\left[4\% - 2.045\left(\frac{20\%}{\sqrt{30}}\right), 4\% + 2.045\left(\frac{20\%}{\sqrt{30}}\right)\right] = [-3.467\%, 11.467\%]$$

**Section:** Quantitative Analysis
**Reference:** Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 7 – Hypothesis Testing and Confidence Intervals
**Learning Objective:** Construct and interpret a confidence interval.

**65.** Suppose that a quiz consists of 20 true-false questions. A student has not studied for the exam and just randomly guesses the answers. How would you find the probability that the student will get 8 or fewer answers correct?

**a.** Find the probability that X = 8 in a binomial distribution with n = 20 and p = 0.5.
**b.** Find the area between 0 and 8 in a uniform distribution that goes from 0 to 20.
**c.** Find the probability that X = 8 for a normal distribution with mean of 10 and standard deviation of 5.
**d.** Find the cumulative probability for 8 in a binomial distribution with n = 20 and p = 0.5.

Answer: D

Explanation: A binomial distribution is a probability distribution, and it refers to the various probabilities associated with the number of correct answers out of the total sample.

The correct approach is to find the cumulative probability for 8 in a binomial distribution with $N$ = 20 and $p$ = 0.5. The cumulative probability is to be calculated on the basis of a binomial distribution with number of questions ($n$) equaling 20 and probability of a single event occurring being 50% ($p$ = 0.5).

**Section:** Quantitative Analysis
**Reference:** Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 4 – Distributions
**Learning Objective:** Distinguish the key properties among the following distributions: uniform distribution, Bernoulli distribution, Binomial distribution, Poisson distribution, normal distribution, lognormal distribution, Chi-squared distribution, Student's t, and F-distributions, and identify common occurrences of each distribution.

**66.** Assume that a random variable follows a normal distribution with a mean of 80 and a standard deviation of 24. What percentage of this distribution is not between 32 and 116?

**a.** 4.56%
**b.** 8.96%
**c.** 13.36%
**d.** 18.15%

Answer: B

Explanation:

Prob(mean - 2*σ < X < mean + 1.5*σ) = (0.5 - 0.0228) + (0.5 - 0.0668) = 0.9104

Prob(mean - 2*σ > X or X > mean + 1.5*σ) = 1 - Prob(mean - 2*σ < X < mean + 1.5*σ) = 0.0896

**Section:** Quantitative Analysis
**Reference:** Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 4 – Distributions
**Learning Objective:** Distinguish the key properties among the following distributions: uniform distribution, Bernoulli distribution, Binomial distribution, Poisson distribution, normal distribution, lognormal distribution, Chi-squared distribution, Student's t, and F-distributions, and identify common occurrences of each distribution.

**67.** An insurance company estimates that 40% of policyholders who have only an auto policy will renew next year, and 60% of policyholders who have only a homeowner policy will renew next year. The company estimates that 80% of policyholders who have both an auto and a homeowner policy will renew at least one of those policies next year. Company records show that 65% of policyholders have an auto policy, 50% of policyholders have a homeowner policy, and 15% of policyholders have both an auto and a homeowner policy. Using the company's estimates, what is the percentage of policyholders that will renew at least one policy next year?

**a.** 20%
**b.** 29%
**c.** 41%
**d.** 53%

Answer: D

Explanation: Let:

*A* = event that a policyholder has an auto policy

*H* = event that a policyholder has a homeowners policy

Then, based on the information given:

$$P(A \cap H) = 0.15$$

$$P(A \cap H^c) = P(A) - P(A \cap H) = 0.65 - 0.15 = 0.5$$

$$P(A^c \cap H) = P(H) - P(A \cap H) = 0.5 - 0.15 = 0.35$$

Therefore, the proportion of policyholders that will renew at least one policy is shown below:

$$0.4 * P(A \cap H^c) + 0.6 * P(A^c \cap H) + 0.8 * P(A \cap H)$$

$$= 0.4 * 0.5 + 0.6 * 0.35 + 0.8 * 0.15 = 0.53$$

**Section:** Quantitative Analysis
**Reference:** Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 2 – Probabilities
**Learning Objective:** Define and calculate a conditional probability, and distinguish between conditional and unconditional probabilities.

**68.** A risk manager is calculating the VaR of a fund with a data set of 25 weekly returns. The mean and standard deviation of weekly returns are 7% and 10%, respectively. Assuming that weekly returns are independent and identically distributed, what is the standard deviation of the mean of the weekly returns?

**a.** 0.4%
**b.** 0.7%
**c.** 2.0%
**d.** 10.0%

Answer: C

Explanation: In order to calculate the standard deviation of the mean of weekly returns, we must divide the standard deviation of the weekly returns by the square root of the sample size. Therefore the correct answer is 10%/sqrt (25) = 2%.

**Section:** Quantitative Analysis
**Reference:** Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 7 – Hypothesis Testing and Confidence Intervals
**Learning Objective:** Calculate and interpret the sample mean and sample variance

**69.** The recent performance of Prudent Fund, with USD 50 million in assets, has been weak and the institutional sales group is recommending that it be merged with Aggressive Fund, a USD 200 million fund. The returns on Prudent Fund are normally distributed with a mean of 3% and a standard deviation of 7% and the returns on Aggressive Fund are normally distributed with a mean of 7% and a standard deviation of 15%. Senior management has asked an analyst to estimate the likelihood that returns on the combined portfolio will exceed 26%. Assuming the returns on the two funds are independent, the analyst's estimate for the probability that the returns on the combined fund will exceed 26% is closest to:

**a.** 1.0%
**b.** 2.5%
**c.** 5.0%
**d.** 10.0%

Answer: C

Explanation: Since these are independent normally distributed random variables, the combined expected mean return is:

$$\mu = 0.2 * 3\% + 0.8 * 7\% = 6.2\%$$

Combined volatility is:

$$\sigma = \sqrt{0.2^2 0.07^2 + 0.8^2 0.15^2} = 0.121 = 12.1\%$$

The appropriate Z-statistic is $Z = \frac{26\% - 6.2\%}{12.1\%} = 1.64$

and therefore P(Z>1.64) = 1 - .095 = .05 = 5%

**Section:** Quantitative Analysis
**Reference:** Michael Miller, *Mathematics and Statistics for Financial Risk Management, 2nd Edition* (Hoboken, NJ: John Wiley & Sons, 2013), Chapter 3 – Basic Statistics
**Learning Objective:** Calculate the mean and variance of sums of variables.

**70.** Which of the following four statements on models for estimating volatility is INCORRECT?

**a.** In the exponentially weighted moving average (EWMA) model, some positive weight is assigned to the long-run average variance.
**b.** In the EWMA model, the weights assigned to observations decrease exponentially as the observations become older.
**c.** In the GARCH (1, 1) model, a positive weight is estimated for the long-run average variance.
**d.** In the GARCH (1, 1) model, the weights estimated for observations decrease exponentially as the observations become older.

Answer: A

Explanation: The EWMA model does not involve the long-run average variance in updating volatility, in other words, the weight assigned to the long-run average variance is zero. Only the current estimate of the variance is used. The other statements are all correct.

**Section:** Quantitative Analysis
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 23 - Estimating Volatilities and Correlations for Risk Management
**Learning Objective:** Explain the weights in the EWMA and GARCH (1,1) models.

**71.** A stock index is valued at USD 750 and pays a continuous dividend at the rate of 2% per annum. The 6-month futures contract on that index is trading at USD 757. The risk-free rate is 3.50% continuously compounded. Assuming no transaction costs or taxes, which of the following numbers comes closest to the arbitrage profit that can be realized by taking a position in one futures contract?

**a.** 4.18
**b.** 1.35
**c.** 12.60
**d.** There is no arbitrage opportunity.

Answer: B

Explanation: The formula for computing the forward price on a financial asset is:

$$F_{0,T} = S_0 e^{(r-\delta)T}$$

where $S_0$ is the spot price of the asset, r is the continuously compounded interest rate, and δ is the continuous dividend yield on the asset.

The no-arbitrage futures price is computed as follows:

$$750e^{(0.035 - 0.02)*0.5} = 755.65$$

Since the market price of the futures contract is higher than this price, there is an arbitrage opportunity. The futures contract could be sold and the index purchased.

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 5 – Determination of Forward and Futures Prices
**Learning Objective:** Calculate the forward price given the underlying asset's spot price, and describe an arbitrage argument between spot and forward prices.

**72.** On Nov. 1, a fund manager of a USD 60 million U.S. medium-to-large cap equity portfolio, considers locking up the profit from the recent rally. The S&P 500 index and its futures with the multiplier of 250 are trading at 900 and 910, respectively. Instead of selling off the holdings, the fund manager would rather hedge two-thirds of his market exposure over the remaining two months. Given that the correlation between the portfolio and the S&P 500 index futures is 0.89 and the volatilities of the equity fund and the futures are 0.51 and 0.48 per year, respectively, what position should the manager take to achieve the objective?

**a.** Sell 250 futures contracts of S&P 500
**b.** Sell 169 futures contracts of S&P 500
**c.** Sell 167 futures contracts of S&P 500
**d.** Sell 148 futures contracts of S&P 500

Answer: C

Explanation: The optimal hedge ratio is the product of the correlation coefficient between the change in the spot price and the change in futures price and the ratio of the volatility of the equity fund and the futures. Two-thirds of the equity fund is worth USD 40 million. The optimal hedge ratio computed:

$$h = 0.89 * (0.51/0.48) = 0.945$$

Computing the number of futures contracts:

N=0.945 * 40,000,000/(910 * 250) = 166.26 = 167, round up to nearest integer.

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 3 – Hedging Strategies Using Futures
**Learning Objective:** Compute the optimal number of futures contracts needed to hedge an exposure, and explain and calculate the “tailing the hedge” adjustment.

**73.** The following statement is made by S&P about the creditworthiness of company XYZ: "Strong capacity to meet financial commitments, but somewhat susceptible to adverse economic conditions and changes in circumstances." What is the rating assigned by S&P to company XYZ?

**a.** AAA
**b.** A
**c.** B
**d.** C

Answer: B

Explanation: The interpretation the statement refers to is a rating of A. The interpretations for each of the ratings are:

AAA—Extremely strong capacity to meet financial commitments

A—Strong capacity to meet financial commitments

B—Very speculative with significant credit risk

C—In bankruptcy or default

**Section:** Financial Markets and Products
**Reference:** John B. Caouette, Edward I. Altman, Paul Narayanan, and Robert W.J. Nimmo, *Managing Credit Risk: The Great Challenge for Global Financial Markets, 2nd Edition* (New York: John Wiley & Sons, 2008), Chapter 6 - The Rating Agencies
**Learning Objective:** Describe Standard and Poor's and Moody's rating scales and distinguish between investment and noninvestment grade ratings.

**74.** Company XYZ operates in the U.S. On April 1, 2009, it has a net trade receivable of EUR 5,000,000 from an export contract to Germany. The company expects to receive this amount on Oct. 1, 2009. The CFO of XYZ wants to protect the value of this receivable. On April 1, 2009, the EUR spot rate is 1.34, and the 6-month EUR forward rate is 1.33. The CFO can lock in an exchange rate by taking a position in the forward contract. Alternatively, he can sell a 6-month EUR 5,000,000 call option with strike price of 1.34. The CFO thinks that selling an option is better than taking a forward position because if the EUR goes up, XYZ can take delivery of the USD at 1.34, which is better than the outright forward rate of 1.33.

If the EUR goes down, the contract will not be exercised. So, XYZ will pocket the premium obtained from selling the call option. What can be concluded about the CFO's analysis?

- **a.** The CFO's analysis is correct. The company is better off whichever way the EUR rate goes.
- **b.** The CFO's analysis is not correct. The company will suffer if the EUR goes up sharply.
- **c.** The CFO's analysis is not correct. The company will suffer if the EUR moves within a narrow range.
- **d.** The CFO's analysis is not correct. The company will suffer if the EUR goes down sharply.

Answer: D

Explanation: The CFO's analysis is incorrect because there is unlimited downside risk. The option premium received is a fixed amount, and if the EUR declines sharply, the value of the underlying receivable goes down as well. If instead the EUR moves in a narrow range, that would be good, but there is no guarantee of course that this will occur.

**Section:** Financial Markets and Products
**Reference:** John Hull, Options, Futures, and Other Derivatives, 9th Edition (New York: Pearson, 2014), Chapter 10. Mechanics of Options Markets
**Learning Objective:** Describe the types, position variations, and typical underlying assets of options.

**75.** An investor with a long position in a futures contract wants to issue instructions to close out the position. A market-if-touched order would be used if the investor wants to:

- **a.** Execute at the best available price once a trade occurs at the specified or better price.
- **b.** Execute at the best available price once a bid/offer occurs at the specified or worse price.
- **c.** Allow a broker to delay execution of the order to get a better price.
- **d.** Execute the order immediately or not at all.

Answer: A

Explanation: A market-if-touched order executes at the best available price once a trade occurs at the specified or better price. A stop order executes at the best available price once a bid/offer occurs at the specified or worse price. A discretionary order allows a broker to delay execution of the order to get a better price. A fill-or-kill order executes the order immediately or not at all.

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 2 – Mechanics of Futures Markets
**Learning Objective:** Evaluate the impact of different trading order types.

**76.** Below is a table of term structure of swap rates:

| Maturity in Years | Swap Rate |
|---|---|
| 1 | 2.50% |
| 2 | 3.00% |
| 3 | 3.50% |
| 4 | 4.00% |
| 5 | 4.50% |

The 2-year forward swap rate starting in three years is closest to:

- **a.** 3.50%
- **b.** 4.50%
- **c.** 5.51%
- **d.** 6.02%

Answer: D

Explanation: Computing the 2-year forward swap rate starting in three years:

$$6.02\% = [(1.045^5/(1.035^3))^{(1/2)}]$$

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 4 – Interest Rates
**Learning Objective:** Derive forward interest rates from a set of spot rates.

**77.** Three months ago, a company entered in a one-year forward contract to buy 100 ounces of gold. At the time, the one-year forward price was USD 1,000 per ounce. The nine-month forward price of gold is now USD 1,050 per ounce. The continuously-compounded risk-free rate is 4% per year for all maturities, and there are no storage costs. Which of the following is closest to the value of the contract?

- **a.** USD 1,897
- **b.** USD 4,852
- **c.** USD 5,000
- **d.** USD 7,955

Answer: B

Explanation: The forward price is computed as follows:

$F_0 = 100 \times (F_0 - K)e^{-rT}$

$F_0 = 1{,}050$

$K = 1{,}000$

$r = 0.04$

$T = 0.75$

$F = 100 \times (1050 - 1000)e^{-0.04*0.75} = 4{,}852$

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 5 – Determination of Forward and Futures Prices
**Learning Objective:** Calculate the forward price given the underlying asset's spot price, and describe an arbitrage argument between spot and forward prices.

**78.** Calculate the impact of a 10 basis point increase in yield on the following bond portfolio:

| Bond | Value (USD) | Modified Duration |
|---|---|---|
| 1 | 4,000,000 | 7.5 |
| 2 | 2,000,000 | 1.6 |
| 3 | 3,000,000 | 6.0 |
| 4 | 1,000,000 | 1.3 |

**a.** USD -525,000
**b.** USD -410,000
**c.** USD -52,500
**d.** USD -41,000

Answer: C

Explanation:

| (A) | (B) | (C) | (D) | (E) |
|---|---|---|---|---|
| **Bond** | **Value (USD)** | **Modified Duration** | **(BxC)** | **(D/B)** |
| 1 | 4,000,000 | 7.5 | 30,000,000 | |
| 2 | 2,000,000 | 1.6 | 3,200,000 | |
| 3 | 3,000,000 | 6.0 | 18,000,000 | |
| 4 | 1,000,000 | 1.3 | 1,300,000 | |
| SUM | 10,000,000 | | 52,500,000 | 5.25 |

The portfolio modified duration is 5.25. This is obtained by multiplying the value of each bond by the modified duration(s), then taking the sum of these products, and dividing it by the value of the total bond portfolio. The change in the value of the portfolio will be -10,000,000 x 5.25 x 0.1% = -52,500

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 4 – Interest Rates
**Learning Objective:** Calculate the change in a bond's price given its duration, its convexity, and a change in interest rates.

**79.** An oil producer has an obligation under an agreement to supply one million barrels of oil at a fixed price. The producer wishes to hedge this liability using futures in order to address the possibility of an upward movement in oil prices. In comparing a strip hedge to a stack and roll hedge, which of the following statements is correct?

**a.** A stack and roll hedge tends to involve fewer transactions.
**b.** A strip hedge tends to have smaller bid-ask spreads.
**c.** A stack and roll hedge tends to have greater liquidity.
**d.** A strip hedge tends to realize gains and losses more frequently.

Answer: C

Explanation: A strip hedge involves one-time buying of futures contracts to match the maturity of liabilities, whereas the stack and roll hedge involves multiple purchases over time. A strip hedge tends to have wider bid-ask spreads due to the use of longer maturity contracts. A strip hedge also tends to have lesser liquidity than a stack and roll hedge due to longer maturity contracts. Both a strip hedge and stack and roll hedge would realize gains/losses daily using futures.

**Section:** Financial Markets and Products
**Reference:** Robert McDonald, *Derivatives Markets, 3rd Edition* (Boston: Pearson, 2012), Chapter 6 - Commodity Forwards and Futures
**Learning Objective:** Evaluate the differences between a strip hedge and a stack hedge and explain how these differences impact risk management.

**80.** A risk manager wishes to hedge an investment in zirconium using futures. Unfortunately, there are no futures that are based on this asset. To determine the best futures contract to hedge with, the risk manager runs a regression of daily changes in the price of zirconium against daily changes in the prices of similar assets that have futures contracts associated with them. Based on the results, futures tied to which asset would likely introduce the least basis risk into your hedging position?

| Change in Price of Zirconium = α + β (Change in Price of Asset) | | | |
|---|---|---|---|
| **Asset** | **α** | **β** | ***R*²** |
| A | 1.25 | 1.03 | 0.62 |
| B | 0.67 | 1.57 | 0.81 |
| C | 0.01 | 0.86 | 0.35 |
| D | 4.56 | 2.30 | 0.45 |

**a.** Asset A
**b.** Asset B
**c.** Asset C
**d.** Asset D

Answer: B

Explanation: Futures on an asset whose price changes are most closely correlated with the asset you are looking to hedge will have the least basis risk. This is determined by examining the $R^2$ of the regressions and choosing the highest one. $R^2$ is the most applicable statistic in the above chart to determine correlation with the price of zirconium.

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 3 – Hedging Strategies Using Futures
**Learning Objective:** Define cross hedging, and compute and interpret the minimum variance hedge ratio and hedge effectiveness.

**81.** A homeowner has a 30-year, 5% fixed-rate mortgage with a current balance of USD 250,000. Mortgage rates have been decreasing. If the existing mortgage was refinanced into a new 30-years, 4% fixed rate mortgage, which of the following is closest to the amount that the homeowner would save in monthly mortgage payments?

**a.** USD 145
**b.** USD 150
**c.** USD 155
**d.** USD 160

Answer: B

Explanation:

Calculate the mortgage payment factors for the 30-year, 5% and 4% fixed rate mortgages, then calculate the mortgage payment savings.

Total monthly payment 5 Mortgage payment factor * Principal balance

Mortgage payment factor: $r(1 + r)^n/(1 + r)^n - 1$
where $r$ = the interest rate, and n = the number of payments over the loan term.
5% factor = 0.005368216; 4% factor = 0.004774153;
Savings = $250,000*(0.005368216 - 0.004774153) = 148.52

**Section:** Financial Markets and Products
**Reference:** Bruce Tuckman, Angel Serrat, *Fixed Income Securities: Tools for Today's Markets, 3rd Edition* (Hoboken, NJ: John Wiley & Sons, 2011), Chapter 20 - Mortgages and Mortgage-Backed Securities
**Learning Objective:** Calculate a fixed rate mortgage payment, and its principal and interest components.

**82.** The current stock price of a share is USD 100, and the continuously compounding risk-free rate is 12% per year. If the strike price for all options is USD 90, what are the maximum possible prices for a 3-month European call option, American call option, European put option, and American put option?

**a.** 97.04, 97.04, 87.34, 87.34
**b.** 97.04, 100, 90, 90
**c.** 100, 100, 87.34, 90
**d.** 100, 100, 90, 90

Answer: C

Explanation: For European and American call options, the maximum possible price is equal to current stock price. The option price can never be higher than the stock. The stock price is thus the "upper bound." For a European Put, the upper bound is the present value of strike price, while for American put, it is equal to the strike price.

**Section:** Financial Markets and Products
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 11 – Properties of Stock Options
**Learning Objective:** Identify and compute upper and lower bounds for option prices on non-dividend and dividend paying stocks.

**83.** An analyst has been asked to estimate the VaR of an investment in Big Pharma Inc. The company's stock is trading at USD 23, and the stock has a daily volatility of 1.5%. Using the delta-normal method, the VaR at the 95% confidence level of a long position in an at-the-money put on this stock with a delta of -0.5 over a 1-day holding period is closest to which of the following choices?

**a.** USD 0.28
**b.** USD 0.40
**c.** USD 0.57
**d.** USD 2.84

Answer: A

Explanation:

$\text{VaR} = |\Delta| * 1.645 * \sigma * S = 0.5 * 1.645 * 0.015 * \$23 = \$0.28$

The $\Delta$ of an at-the-money put is -0.5, and the absolute value of the $\Delta$ is 0.5.

**Section:** Valuation and Risk Models
**Reference:** Linda Allen, Jacob Boudoukh and Anthony Saunders, *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (New York: Wiley-Blackwell, 2004) - Chapter 3. Putting VaR to Work
**Learning Objective:** Describe the delta-normal approach to calculating VaR for non-linear derivatives.

**84.** Assume that portfolio daily returns are independently and identically normally distributed. A new quantitative analyst has been asked by the portfolio manager to calculate portfolio VaRs for 10-, 15-, 20-, and 25-day periods. The portfolio manager notices something amiss with the analyst's calculations displayed below. Which one of following VaRs on this portfolio is inconsistent with the others?

**a.** VaR(10-day) = USD 316M
**b.** VaR(15-day) = USD 465M
**c.** VaR(20-day) = USD 537M
**d.** VaR(25-day) = USD 600M

Answer: A

Explanation: The calculations follow. Calculate VaR(1-day) from each choice:

VaR(10-day) = 316 → VaR( 1-day) = $316/\sqrt{10}$ = 100

VaR(15-day) = 465 → VaR( 1-day) = $465/\sqrt{15}$ = 120

VaR(20-day) = 537 → VaR( 1-day) = $537/\sqrt{20}$ = 120

VaR(25-day) = 600 → VaR( 1-day) = $600/\sqrt{25}$ = 120

VaR(1-day) from "a" is different from those from other answers.

**Section:** Valuation and Risk Models
**Reference:** Linda Allen, Jacob Boudoukh and Anthony Saunders, *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (New York: Wiley-Blackwell, 2004), Chapter 2 – Quantifying Volatility in VaR Models
**Learning Objective:** Explain long horizon volatility/VaR and the process of mean reversion according to an AR(1) model.

**85.** A portfolio manager uses a valuation model to estimate the value of a bond portfolio at USD 125.482 million. The term structure is flat. Using the same model, the portfolio manager estimates that the value of the portfolio would increase to USD 127.723 million if all interest rates fell by 30 basis points and would decrease to USD 122.164 million if all interest rates rose by 30 basis points. Using these estimates, the effective duration of the bond portfolio is closest to:

**a.** 7.38
**b.** 8.38
**c.** 14.77
**d.** 16.76

Answer: A

Explanation: Duration is the approximate percentage change in price for every 100 basis point change in rates.

The calculation follows:

$$D = \frac{V_{-} - V_{+}}{2 * V_0 * \Delta y} = \frac{127.723 - 122.164}{2 * 125.482 * 0.003} = 7.38$$

**Section:** Valuation and Risk Models
**Reference:** Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: John Wiley & Sons, 2011), Chapter 4 - One-Factor Risk Metrics and Hedges
**Learning Objective:** Explain the process of calculating the effective duration and convexity of a portfolio of fixed income securities.

**86.** A trading portfolio consists of two bonds, A and B. Both have modified duration of three years and face value of USD 1,000. A is a zero-coupon bond, and its current price is USD 900. Bond B pays annual coupons and is priced at par. What is expected to happen to the market prices of A and B if the risk-free yield curve moves up by one basis point?

**a.** Both bond prices will move up by roughly the same amount.
**b.** Both bond prices will move up, but bond B will gain more than bond A.
**c.** Both bond prices will move down by roughly equal amounts.
**d.** Both bond prices will move down, but bond B will lose more than bond A.

Answer: D

Explanation: Assuming parallel movements to the yield curve, the expected price change is:

$\Delta P = -P\Delta y * D$

where P is the current price or net present value

$\Delta y$ is the yield change

D is duration

All else equal, a negative impact of a yield curve move is stronger in absolute terms at the bond which is currently priced higher. Upward parallel curve movements makes bonds cheaper.

**Section:** Valuation and Risk Models
**Reference:** Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: John Wiley & Sons, 2011), Chapter 3 – Returns, Spreads and Yields
**Learning Objective:** Define the coupon effect and explain the relationship between coupon rate, YTM, and bond prices.

**Common text for questions 87 and 88:**

A risk manager for Bank XYZ is considering writing a 6-month American put option on a non-dividend paying stock ABC. The current stock price is USD 50, and the strike price of the option is USD 52. In order to find the no-arbitrage price of the option, the manager uses a two-step binomial tree model. The stock price can go up or down by 20% each period. The manager's view is that the stock price has an 80% probability of going up each period and a 20% probability of going down. The annual risk-free rate is 12% with continuous compounding.

**87.** What is the risk-neutral probability of the stock price going up in a single step?

- **a.** 34.5%
- **b.** 57.6%
- **c.** 65.5%
- **d.** 80.0%

Answer: B

Explanation: Calculation follows:

$$p_{up} = \frac{e^{r\Delta t} - d}{u - d} = \frac{e^{0.12*3/12} - 0.8}{1.2 - 0.8} = 57.61\% \quad p_{down} = 1 - p_{up} = 42.39\%$$

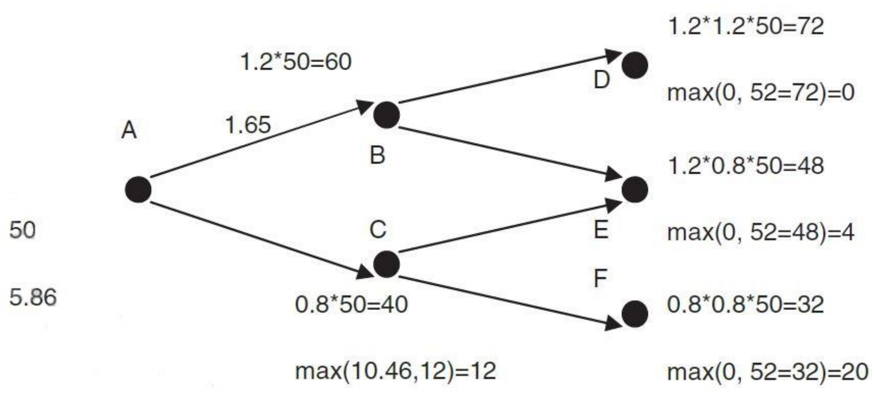
**Section:** Valuation and Risk Models
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 13 - Binomial Trees
**Learning Objective:** Calculate the value of an American and a European call or put option using a one-step and two-step binomial model.

**88.** The no-arbitrage price of the option is closest to:

**a.** USD 2.00
**b.** USD 2.93
**c.** USD 5.22
**d.** USD 5.86

Answer: D

Explanation: The risk-neutral probability of an up move is 57.61% (calculated in the previous question).




The figure shows the stock price and the respective option value at each node. At the final nodes, the value is calculated as max(0, KS).

Node B: (0.5761*0+0.4239*4)*exp(-0.12*3/12)=1.65, which is greater than the intrinsic value of the option at this node equal to max(0, 52-60)=0, so the option should not be exercised early at this node.

Node C: (0.5761*4+0.4239*20)*exp(-0.12*3/12)=10.46, which is lower than the intrinsic value of the option at this node equal to max(0, 52-40)=12, so the option should be exercised early at node C with the value of the option at node C being 12.

Node A: (0.5761*1.65+0.4239*12)*exp(-0.12*3/12)=5.86, which is greater than the intrinsic value of the option at this node equal to max(0, 52-50) = 2, so the option should not be exercised early at this node.

**Section:** Valuation and Risk Models
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 13 - Binomial Trees
**Learning Objective:** Calculate the value of an American and a European call or put option using a one-step and two-step binomial model.

**89.** Which of the following statements is correct about the early exercise of American options?

**a.** It is always optimal to exercise an American call option on a non-dividend-paying stock before the expiration date.
**b.** It can be optimal to exercise an American put option on a non-dividend-paying stock early.
**c.** It can be optimal to exercise an American call option on a non-dividend-paying stock early.
**d.** It is never optimal to exercise an American put option on a non-dividend-paying stock before the expiration date.

Answer: B

Explanation: It is never optimal to exercise an American call option on a non-dividend-paying stock before the expiration date, but at any given time during its life, a put option could be exercised early if it is sufficiently deep in the money. Thus, it can be optimal to exercise an American put option on a non-dividend-paying stock early.

**Section:** Valuation and Risk Models
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 15 – The Black-Sholes-Merton Model
**Learning Objective:** Explain how dividends affect the decision to exercise early for American call and put options.

**90.** A manager is responsible for the options desk in a London bank and is concerned about the impact of dividends on the options held by the options desk. The manager asks an analyst to assess which options are the most sensitive to dividend payments. What would be the analyst's answer if the value of the options is found by using the Black-Scholes model adjusted for dividends?

**a.** Everything else equal, out-of-the-money call options experience a larger decrease in value than in-the-money call options as expected dividends increase.
**b.** The increase in the value of in-the-money put options caused by an increase in expected dividends is always larger than the decrease in value of in-the-money call options.
**c.** Keeping the type of option constant, in-the-money options experience the greatest absolute change in value and out-of-the-money options the smallest absolute change in value as expected dividends increase.
**d.** Keeping the type of option constant, at-the-money options experience the largest absolute change in value and out-of-the-money options the smallest absolute change in value as a result of dividend payment.

Answer: C

Explanation: In the Black-Scholes framework, an in-the-money option is expected to change its value the most and out-of-money the least as a result of dividend payments. For the purpose of illustration, the impact of dividend payment on the option is characterized by:

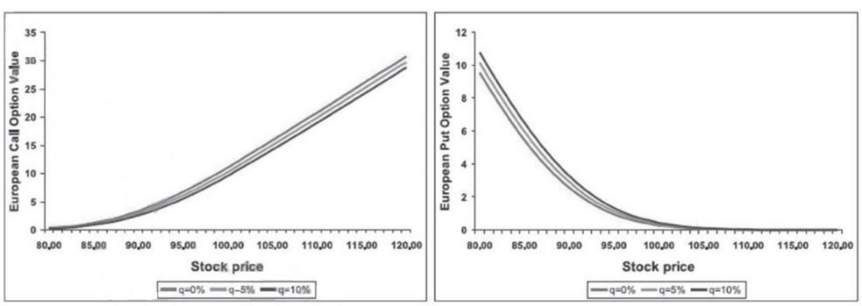
S=93

K=90

T=60 days

R=5%

S=20%




**Section:** Valuation and Risk Models
**Reference:** John Hull, *Options, Futures, and Other Derivatives, 9th Edition* (New York: Pearson, 2014), Chapter 15 – The Black-Sholes-Merton Model
**Learning Objective:** Compute the value of a European option using the Black-Scholes-Merton model on a dividend-paying stock.

**91.** A portfolio of investment securities for a regional bank has a current market value equal to USD 6,247,000 with a daily variance of 0.0002. Assuming there are 250 trading days in a year and that the portfolio returns follow a normal distribution, the estimate of the annual VaR at the 95% confidence level is closest to which of the following?

- **a.** USD 32,595
- **b.** USD 145,770
- **c.** USD 2,297,507
- **d.** USD 2,737,868

Answer: C

Explanation:

Daily standard deviation = $0.0002^{0.5} = 0.01414$.

Annual VaR = $6{,}247{,}000 \times 250^{0.5} \times 0.01414 \times 1.645 = 2{,}297{,}507$

**Section:** Valuation and Risk Models
**Reference:** Linda Allen, Jacob Boudoukh and Anthony Saunders, *Understanding Market, Credit and Operational Risk: The Value at Risk Approach* (New York: Wiley-Blackwell, 2004), Chapter 2 – Quantifying Volatility in VaR Models
**Learning Objective:** Explain long horizon volatility/VaR and the process of mean reversion according to an AR(1) model.

**92.** You are using key rate shifts to analyze the effect of yield changes on bond prices. Suppose that the 10-year yield has increased by ten basis points and that this shock decreases linearly to zero for the 20-year yield. What is the effect of this shock on the 14-year yield?

- **a.** increase of zero basis points
- **b.** increase of four basis points
- **c.** increase of six basis points
- **d.** increase of ten basis points

Answer: C

Explanation: The 10 basis point shock to the 10-year yield is supposed to decline linearly to zero for the 20-year yield. Thus, the shock decreases by one basis point per year and will result in an increase of six basis points for the 14-year yield.

**Section:** Valuation and Risk Models
**Reference:** Bruce Tuckman, *Fixed Income Securities, 3rd Edition* (Hoboken, NJ: John Wiley & Sons, 2011), Chapter 5 – Multi-Factor Risk Metrics and Hedges
**Learning Objective:** Describe key-rate shift analysis.

**93.** The efficient frontier is defined by the set of portfolios that, for each volatility level, maximizes the expected return. According to the capital asset pricing model (CAPM), which of the following statements is correct with respect to the efficient frontier?

**a.** The capital market line always has a positive slope and its steepness depends on the market risk premium and the volatility of the market portfolio.
**b.** The capital market line is the straight line connecting the risk-free asset with the zero beta minimum variance portfolio.
**c.** Investors with the lowest risk aversion will typically hold the portfolio of risky assets that has the lowest standard deviation on the efficient frontier.
**d.** The efficient frontier allows different individuals to have different portfolios of risky assets based upon their individual forecasts for asset returns.

Answer: A

Explanation: The capital market line connects the risk-free asset with the market portfolio, which is the efficient portfolio at which the capital market line is tangent to the efficient frontier. The equation of the capital market line is as follows:

$$\bar{R}_e = R_F + \frac{\bar{R}_M - R_F}{\sigma_M}\sigma_e$$

where the subscript e denotes an efficient portfolio. Since the shape of the efficient frontier is dictated by the market risk premium, $(\bar{R}_M - R_F)$, and the volatility of the market, the slope of the capital market line will also be dependent on these two factors.

**Section:** Foundations of Risk Management
**Reference:** Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann, *Modern Portfolio Theory and Investment Analysis, 9th Edition* (Hoboken, NJ: John Wiley & Sons, 2014), Chapter 13 - The Standard Capital Asset Pricing Model
**Learning Objective:** Understand the derivation and components of the CAPM.
Interpret the capital market line.

**94.** Suppose that the correlation of the return of a portfolio with the return of its benchmark is 0.8, the volatility of the return of the portfolio is 5%, and the volatility of the return of the benchmark is 4%. What is the beta of the portfolio?

**a.** 1.00
**b.** 0.64
**c.** 0.80
**d.** -1.00

Answer: A

Explanation: The following equation is used to calculate beta:

$$\beta = \rho \frac{\sigma(portfolio)}{\sigma(benchmark)} = 0.8 * \frac{0.05}{0.04} = 1.00$$

Where ρ represents the correlation coefficient and σ the volatility.

**Section:** Foundations of Risk Management
**Reference:** Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann, *Modern Portfolio Theory and Investment Analysis, 9th Edition* (Hoboken, NJ: John Wiley & Sons, 2014), Chapter 13 - The Standard Capital Asset Pricing Model
**Learning Objective:** Understand the derivation and components of the CAPM.

**95.** In characterizing various dimensions of a bank's data, the Basel Committee has suggested several principles to promote strong and effective risk data aggregation capabilities. Which statement correctly describes a recommendation that the bank should follow in accordance with the given principle?

**a.** The integrity principle recommends that data aggregation should be completely automated without any manual intervention.
**b.** The completeness principle recommends that a financial institution should capture data on its entire universe of material risk exposures.
**c.** The adaptability principle recommends that a bank should frequently update its risk reporting systems to incorporate changes in best practices.
**d.** The accuracy principle recommends that the risk data be reconciled with management's estimates of risk exposure prior to aggregation.

Answer: B

Explanation: The completeness principle recommends that a bank be able to capture and aggregate all data on the material risks to which it is exposed across the organization. This will allow it to identify and report risk exposures, concentrations, and set exposure limits.

**Section:** Foundations of Risk Management
**Reference:** "Principles for Effective Data Aggregation and Risk Reporting," (Basel Committee on Banking Supervision Publication, January 2013)
**Learning Objective:** Describe key governance principles related to risk data aggregation and risk reporting practices.

**96.** Which of the following is not necessarily considered a failure of risk management?

**a.** Incorrect measurement of known risks
**b.** Failure in communicating risk issues to top management
**c.** Failure to minimize losses on credit portfolios
**d.** Failure to use appropriate risk metrics

Answer: C

Explanation: A failure to minimize losses on credit portfolios is not necessarily a failure of risk management. The firm may have used prudent risk management and decided that the potential rewards from entering into the credit agreements adequately compensated the firm for the risks taken. It could also have ignored the advice of its risk managers to attempt to minimize its credit losses. Either way, this is not necessarily a failure of risk management.

**Section:** Foundations of Risk Management
**Reference:** René Stulz, “Risk Management Failures: What Are They and When Do They Happen?” Fisher College of Business Working Paper Series, October 2008
**Learning Objective:** Analyze and identify instances of risk management failure.

**97.** Portfolio A has an expected return of 8%, volatility of 20%, and beta of 0.5. Assume that the market has an expected return of 10% and volatility of 25%. Also, assume a risk-free rate of 5%. What is Jensen’s alpha for portfolio A?

**a.** 0.5%
**b.** 1.0%
**c.** 10%
**d.** 15%

Answer: A

Explanation: The Jensen measure of a portfolio, or Jensen’s alpha, can be calculated using the following equation:

$$\alpha_P = E(R_P) - R_F - \beta[E(R_M) - R_F]$$

In this example, $\alpha_P = 8\% - 5\% - 0.5 * (10\% - 5\%)$, or 0.5%.

**Section:** Foundations of Risk Management
**Reference:** Noel Amenc and Veronique Le Sourd, *Portfolio Theory and Performance Analysis* (West Sussex, England: John Wiley & Sons, 2003), Chapter 4 - Applying the CAPM to Performance Measurement: Single-Index Performance Measurement Indicators (Section 4.2 only)
**Learning Objective:** Calculate, compare, and evaluate the Treynor measure, the Sharpe measure, and Jensen's alpha.

**98.** According to the Capital Asset Pricing Model (CAPM), over a single time period, investors seek to maximize their:

**a.** Wealth and are concerned about the tails of return distributions.
**b.** Wealth and are not concerned about the tails of return distributions.
**c.** Expected utility and are concerned about the tails of return distributions.
**d.** Expected utility and are not concerned about the tails of return distributions.

Answer: D

Explanation: CAPM assumes investors seek to maximize the expected utility of their wealth at the end of the period, and that when choosing their portfolios, investors only consider the first two moments of the return distribution: the expected return and the variance. Hence, investors are not concerned with the tails of the return distribution.

**Section:** Foundations of Risk Management
**Reference:** Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann, Modern Portfolio Theory and Investment Analysis, 9th Edition (Hoboken, NJ: John Wiley & Sons, 2014), Chapter 13 - The Standard Capital Asset Pricing Model
**Learning Objective:** Describe the assumptions underlying the CAPM.

**99.** An analyst is analyzing the historical performance of two commodity funds tracking the Reuters/Jefferies-CRB® Index (CRB) as benchmark. The analyst collated the data on the monthly returns and decided to use the information ratio (IR) to assess which fund achieved higher returns more efficiently and presented his findings.

| | **Fund I** | **Fund II** | **Benchmark Returns** |
|---|---|---|---|
| Average monthly return | 1.4888% | 1.468% | 1.415% |
| Average excess return | 0.073% | 0.053% | 0.000% |
| Standard deviation of returns | 0.294% | 0.237% | 0.238% |
| Tracking error | 0.344% | 0.341% | 0,000% |

What is the information ratio for each fund, and what conclusion can be drawn?

**a.** IR for Fund I = 0.212, IR for Fund II = 0.155; Fund II performed better as it has a lower IR.
**b.** IR for Fund I = 0.212, IR for Fund II = 0.155; Fund I performed better as it has a higher IR.
**c.** IR for Fund I = 0.248, IR for Fund II = 0.224; Fund I performed better as it has a higher IR.
**d.** IR for Fund I = 0.248, IR for Fund II = 0.224; Fund II performed better as it has a lower IR.

Answer: B

Explanation: The information ratio may be calculated by either a comparison of the residual return to residual risk or the excess return to tracking error. The higher the IR, the better 'informed' the manager is at picking assets to invest in. Since neither residual return nor risk is given, only the latter is an option.
IR = $E(R_p - R_b)$/Tracking Error

For Fund I: IR = 0.00073/0.00344 = 0.212; For Fund II: IR = 0.00053/0.00341 = 0.155

**Section:** Foundations of Risk Management
**Reference:** Noel Amenc and Veronique Le Sourd, Portfolio Theory and Performance Analysis (West Sussex, England: John Wiley & Sons, 2003), Chapter 4 - Applying the CAPM to Performance Measurement: Single-Index Performance Measurement Indicators (Section 4.2 only)
**Learning Objective:** Compute and interpret tracking error, the information ratio, and the Sortino ratio.

**100.** An analyst is estimating the sensitivity of the return of stock A to different macroeconomic factors. The following estimates for the factor betas are prepared:

$$\beta_{\text{Industrial production}} = 1.3 \qquad \beta_{\text{interest rate}} = -0.75$$

Under baseline expectations, with industrial production growth of 3% and an interest rate of 1.5%, the expected return for Stock A is estimated to be 5%.

The economic research department is forecasting an acceleration of economic activity for the following year, with GDP forecast to grow 4.2% and interest rates increasing 25 basis points to 1.75%.

What return of Stock A can be expected for next year according to this forecast?

- **a.** 4.8%
- **b.** 6.4%
- **c.** 6.8%
- **d.** 7.8%

Answer: B

Explanation: The expected return for Stock A equals the expected return for the stock under the baseline scenario, plus the impact of "shocks," or excess returns of, both factors. Since the baseline scenario incorporates 3% industrial production growth and a 1.5% interest rate, the "shocks" are 1.2% for the GDP factor and 0.25% for the interest rate factor.

Therefore the expected return for the new scenario = Baseline scenario expected return +

$\beta_{\text{Industrial production}}$ * Industrial production shock + $\beta_{\text{interest rate}}$ * Interest rate shock

or 5% + (1.3 * 1.2%) + (-0.75 * 0.25%) = 6.37%.

**Section:** Foundations of Risk Management
**Reference:** Zvi Bodie, Alex Kane, and Alan J. Marcus, Investments, 10th Edition (New York: McGraw-Hill, 2013), Chapter 10 - Arbitrage Pricing Theory and Multifactor Models of Risk and Return
**Learning Objective:** Calculate the expected return of an asset using a single-factor and a multi-factor model.