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GOLDEN FUTURE

可信赖的财经培训专家

# 2013 FRM Level II

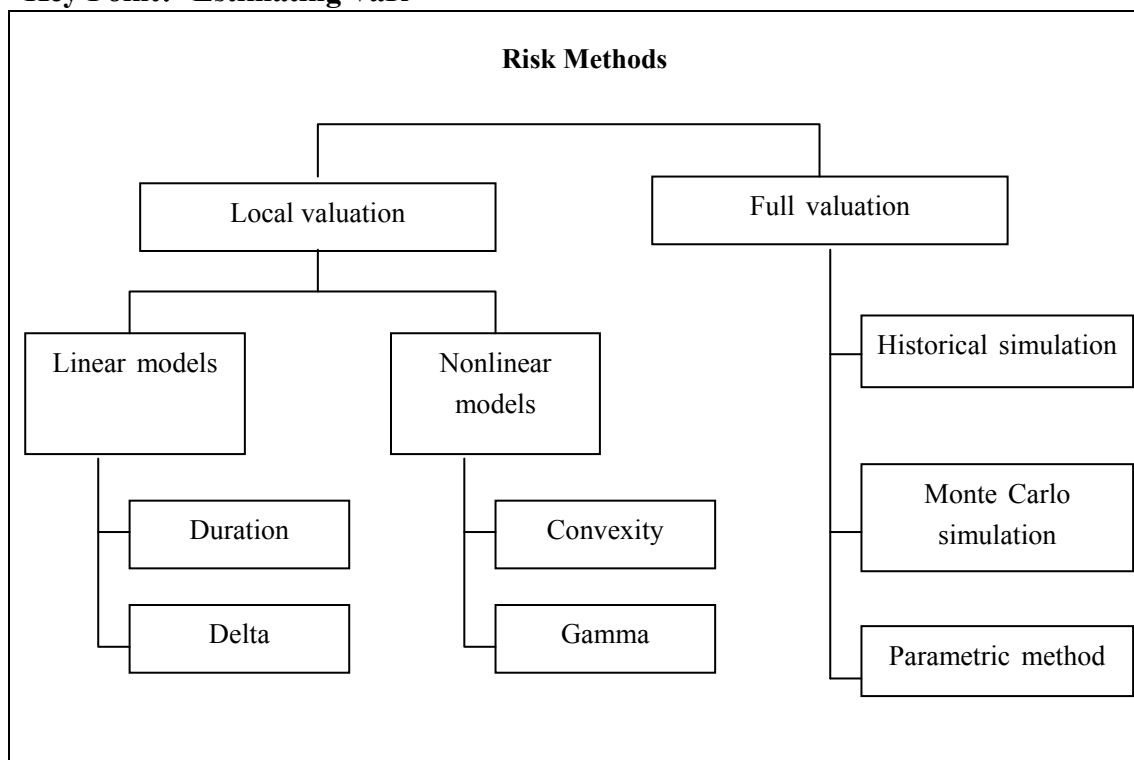
百题巅峰班讲义

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## Part 1: Market Risk Measurement and Management

### Key Point: Estimating VaR



**Normal VAR:**  $VAR(\alpha\%) = (-\mu + \sigma \times z_\alpha) \times P_{t-1}$

$$VAR_{T\text{-days}} = VAR_{1\text{-days}} \times \sqrt{T}$$

$$VAR_p^2 = VAR_1^2 + VAR_2^2 + 2\rho \times VAR_1 \times VAR_2$$

$$VAR(dP) = -D^* P \times VAR(dy)$$

$$VAR(df) = \Delta \times VAR(dS)$$

$$VAR(dP) = -D^* P \times VAR(dy) + (1/2)(C \times P) \times VAR(dy)^2$$

$$VAR(df) = \Delta \times VAR(dS) + (1/2) \Gamma \times VAR(dS)^2$$

**Lognormal VAR:**  $VAR(\alpha\%) = P_{t-1} \times (1 - e^{\mu - \sigma \times z_\alpha})$

**Expected Shortfall/ Conditional VAR (CVAR)/Tail Conditional Expectation/Conditional Loss/Expected Tail Loss:** expected value of the loss when it exceeds VAR

1. The VAR at a 95% confidence level is estimated to be 1.56 from historical simulation of 1,000 observations. Which of the following statements is *most likely* true?

- A. The parametric assumption of normal returns is correct
- B. The parametric assumption of lognormal returns is correct
- C. The historical distribution has fatter tails than a normal distribution.
- D. The historical distribution has thinner tails than a normal distribution.

**Answer: D**

2. A portfolio manager owns a portfolio of options on a non-dividend paying stock RTX. The portfolio is made up of 10,000 deep in-the-money call options on RTX and 50,000 deep out-of-the money call options on RTX. The portfolio also contains 20,000 forward contracts on RTX. RTX is trading at USD 100. If the volatility of RTX is 30% per-year, which of the following amounts would be closest to the 1-day VaR of the portfolio at the 95 percent confidence level, assuming 252 trading days in a year?
- A. USD 932
  - B. USD 93,263
  - C. USD 111,122
  - D. USD 131,892

**Answer: B**

**Explanation:** We need to map the portfolio to a position in the underlying stock RTX. A deep in-the-money call has a delta of approximately 1, a deep out-of-the-money call has delta of approximately 0 and forwards have a delta of 1. The net portfolio has a delta of about 30,000 and is approximately gamma neutral. The 1-day VaR estimate at 95 percent confidence level is computed as follows:

$$\alpha \times S \times \Delta \times \sigma \times \sqrt{1/T} = 1.645 \times 100 \times 30,000 \times 0.30 \times \sqrt{1/252} = 93,263$$

3. A portfolio consists of options on Microsoft and AT&T. The options on Microsoft have a delta of 1000, and the options on AT&T have a delta of 20000. The Microsoft share price is \$120, and the AT&T share price is \$30. Assuming that the daily volatility of Microsoft is 2% and the daily volatility of AT&T is 1% and the correlation between the daily changes is 0.3, the 5-day 95% VaR is
- A. 26193
  - B. 25193
  - C. 27193
  - D. 24193

**Answer: A**

$$\text{VaR}_{\text{Mic}} = 1.65 \times 2\% \times 120 \times 1000 = 3960$$

$$\text{VaR}_{\text{AT\&T}} = 1.65 \times 1\% \times 30 \times 20000 = 9900$$

$$\text{VaR}_{\text{P}(5\text{-day}, 95\%)} = \sqrt{3960^2 + 9900^2 + 2 \times 0.3 \times 3960 \cdot 9900} \times \sqrt{5} = 26193$$

4. After estimating the 99%, 1-day VaR of a bank's portfolio to be USD 1,484 using historical simulation with 1000 past trading days, you are concerned that the VaR measure is not providing enough information about tail losses. You decide to re-examine the simulation results and sort the simulated daily P&L from worst to best giving the following worst 15 scenarios:

Scenario Rank	Daily P/L
1	USD -2,833
2	USD -2,333
3	USD -2,228
4	USD -2,084
5	USD -1,960
6	USD -1,751
7	USD -1,679
8	USD -1,558
9	USD -1,542
10	USD -1,484
11	USD -1,450
12	USD -1,428
13	USD -1,368
14	USD -1,347
15	USD -1,319

What is the 99%, 1-day expected shortfall of the portfolio?

- A. USD 433
- B. USD 1,285
- C. USD 1,945
- D. USD 2,833

**Answer: C**

Explanation:

Expected Shortfall = Average of the worst 10 daily P&L = USD 1945

5. The bank's trading book consists of the following two assets:

Asset	Annual Return	Volatility of Annual Return	Value
A	10%	25%	100
B	20%	20%	50

Correlation (A, B) = 0.2

How would the daily VaR at 99% level change if the bank sells 50 worth of asset A and buys 50 worth of asset B?

Assume there are 250 trading days in a year.

- A. 0.2286
- B. 0.4581
- C. 0.7705
- D. 0.7798

**Answer: B**

Explanation: The trade will decrease the VaR by 0.4581

6. A trader has an option position in crude oil with a delta of 100000 barrels and gamma of -50000 barrels per dollar move in price. Using the delta-gamma methodology, compute the VaR on this position, assuming the extreme move on crude oil is \$2.00 per barrel.
- A. \$100,000
  - B. \$200,000
  - C. \$300,000
  - D. \$400,000

**Answer: C**

$$VAR(df) = \Delta \times VAR(dS) + (1/2) \Gamma \times VAR(dS)^2$$

$$VAR(df) = 100000 \times (-2.00) + (1/2) (-50000) \times (-2.00)^2 = -\$300,000$$

7. The annual mean and volatility of a portfolio are 10% and 40%, respectively. The current value of the portfolio is GBP 1,000,000. How does the 1-year 95% VaR that is calculated using a normal distribution assumption (normal VaR) compare with the 1-year 95% VaR that is calculated using the lognormal distribution assumption (lognormal VaR)?
- A. Lognormal VaR is greater than normal VaR by GBP 13,040
  - B. Lognormal VaR is greater than normal VaR by GBP 17,590
  - C. Lognormal VaR is less than normal VaR by GBP 13,040
  - D. Lognormal VaR is less than normal VaR by GBP 17,590

**Answer: C**

$$\text{Normal VaR} = 0.1 - (1.645 \times 0.4) = 0.558$$

$$\text{Lognormal VaR} = 1 - \exp[0.1 - (1.645 \times 0.4)] = 0.4276$$

Hence, lognormal VaR is smaller than Normal VaR by 13.04% per year. With a portfolio of GBP 1,000,000, this translates to GBP 13,040.

**Key Point: Coherent Risk Measures**

**1. Monotonicity:** if  $X_1 \leq X_2$ ,  $\rho(X_1) \geq \rho(X_2)$ .

In other words, if a portfolio has systematically lower values than another (in each state of the world), it must have greater risk. *Standard deviation violates the monotonicity condition.*

**2. Translation Invariance:**  $\rho(X+k) = \rho(X) - k$ .

In other words, adding cash  $k$  to a portfolio should reduce its risk by  $k$ . This reduces the lowest portfolio value. As with  $X$ ,  $k$  is measured in dollars.

**3. Homogeneity:**  $\rho(bX) = b\rho(X)$ .

In other words, increasing the size of a portfolio by a factor  $b$  should scale its risk measure by the same factor  $b$ . This property applies to the standard deviation.

**4. Subadditivity:**  $\rho(X_1 + X_2) \leq \rho(X_1) + \rho(X_2)$ .

In other words, the risk of a portfolio must be less than the sum of separate risks. Merging portfolios cannot increase risk. *VaR violates the subadditivity condition.*

8. It is not always apparent how risk should be quantified for a given bank when there are many different possible risk measures to consider. Prior to defining specific measures, one should be aware of the general characteristics of ideal risk measures. Such measures should be intuitive, stable, easy to understand, coherent, and interpretable in economic terms. In addition, the risk decomposition process must be simple and meaningful for a given risk measure. Standard deviation, value at risk (VaR), expected shortfall (ES), and spectral and distorted risk measures are commonly used measures to calculate economic capital. However, it is not easy to select a risk measure to calculate economic capital, as each measure has its respective pros and cons. Which of the following statements pertaining to the pros and cons of these risk measures is not accurate?
- A. Standard deviation does not have the property of monotonicity, and therefore, it is not coherent.
  - B. VaR does not have the property of subadditivity, and therefore; it is not coherent.
  - C. ES is not stable regardless of the loss distribution.
  - D. Spectral and distorted risk measures are neither intuitive nor commonly used in practice.

**Answer: C:**

Expected shortfall's stability as a measure of risk depends on the loss distribution.

9. Consider a trader with an investment in a corporate bond with face value of \$100,000 and default probability of 0.5%. Over the next period, we can either have no default, with a return of zero, or default with a loss of \$100,000. The payoffs are thus  $-\$100,000$  with probability of 0.5% and  $+\$0$  with probability of 99.5%. Since the probability of getting \$0 is greater than 99%, the VAR at the 99% confidence level is \$0, without taking the mean into account. This is consistent with the definition that VAR is the smallest loss, such that the right-tail probability is at least 99%. Now, consider a portfolio invested in three bonds (A, B, C) with the same characteristics and independent payoffs. Please compute the portfolio VAR at the

99% confidence level (using loss distribution method):

- A. \$0
- B. \$100,000
- C. \$200,000
- D. \$300,000

**Answer: B**

State	Bonds	Probability	Payoff
No default		$0.995 \times 0.995 \times 0.995 = 0.9850749$	\$0
1 default	A,B,C	$3 \times 0.005 \times 0.995 \times 0.995 = 0.0148504$	-\$100,000
2 defaults	AB,AC,BC	$3 \times 0.005 \times 0.005 \times 0.995 = 0.0000746$	-\$200,000
3 defaults	ABC	$0.005 \times 0.005 \times 0.005 = 0.0000001$	-\$300,000

Here, the probability of zero or one default is  $0.9851 + 0.0148 = 99.99\%$ . The portfolio VAR is therefore \$100,000, which is the lowest number, such that the probability exceeds 99%. Note that the portfolio VAR is greater than the sum of individual VARs. In this example, VAR is not subadditive. This is an undesirable property because it creates disincentives to aggregate the portfolio, since it appears to have higher risk.

**Key Point: Non-Parametric Approaches (computing VAR)**

**Bootstrap historical simulation approach:** *involves repeated sampling with replacement, the 5% VAR is recorded from each sample draw. The average of the VARs from all the draws is the VAR estimate.* Note: empirical analysis demonstrates that the bootstrapping technique consistently provides more precise estimates of coherent risk measures than historical simulation on raw data alone.

**Weighted historical simulation approach:**

- *Age-weighted historical simulation:*  $w(i) = \frac{\lambda^{i-1}(1-\lambda)}{1-\lambda^n}$
- *Volatility-weighted historical simulation:*  $r_{t,i}^* = \left( \frac{\sigma_{T,i}}{\sigma_{t,i}} \right) \times r_{t,i}$
- *Correlation-weighted historical simulation:* Intuitively, the historical correlation matrix needs to be adjusted to the new information environment. This is accomplished, loosely speaking, by “multiplying” the historic returns by the revised correlation matrix to yield updated correlation-adjusted returns.
- *Filtered historical simulation:* Combines the traditional historical simulation model with GARCH model.

10. Johanna Roberto has collected a data set of 1,000 daily observations on equity returns. She is concerned about the appropriateness of using parametric techniques as the data appears

skewed. Ultimately, she decides to use historical simulation and bootstrapping to estimate the 5% VaR. which of the following steps is most likely to be part of the estimation procedure?

- A. Filter the data to remove the obvious outliers.
- B. Repeated sampling with replacement.
- C. Identify the tail region from reordering the original data.
- D. Apply a weighting procedure to reduce the impact of older data.

**Answer: B**

Bootstrapping from historical simulation involves repeated sampling with replacement. The 5% VaR is recorded from each sample draw. The average of the VaRs from all the draws is the VaR estimate. The bootstrapping procedure does not involve filtering the data or weighting observations. Note that the VaR from the original data set is not used in the analysis.

11. Jack has collected a large data set of daily market returns for three emerging markets and he want to compute the VAR. He is concerned about the non-normal skew in the data and is considering non-parametric estimation methods. Which of the following statements about Age-weighted histocial simulation approach is *most accurate*?

- A. The age-weighted procedure incorporate estimates from GARCH model.
- B. If the decay factor in the model is close to 1, there is persistence within the data set.
- C. When using this approach, the weight assigned on day  $i$  is equal to:

$$w(i) = \lambda^{i-1}(1-\lambda)/1-\lambda^i$$

- D. The number of observation should at least exceed 250.

**Answer: B**

If the intensity parameter (i.e., decay factor) is close to 1, there will be persistence (i.e., slow decay) in the estimate. The expression for the weight on day  $i$  has  $i$  in the exponent when it should be  $n$ . While a large sample size is generally preferred, some of the data may no longer be representative in a large sample.

### Key Point: Modeling Dependence: Correlations and Copulas

$$\text{Correlation: } \rho_{XY} = \frac{\text{COV}_{(X,Y)}}{\sigma_X \sigma_Y}$$

$$\text{Copulas: } f_{12}(x_1, x_2) = f_1(x_1) \times f_2(x_2) \times c_{12}[F_1(x_1), F_2(x_2); \theta]$$

12. Which of the following statements about correlation and copula are correct?

- i. Copula enables the structures of correlation between variables to be calculated separately from their marginal distributions.
- ii. Transformation of variables does not change their correlation structure.
- iii. Correlation can be a useful measure of the relationship between variables drawn from a



distribution without a defined variance.

iv. Correlation is a good measure of dependence when the measured variables are distributed as multivariate elliptical.

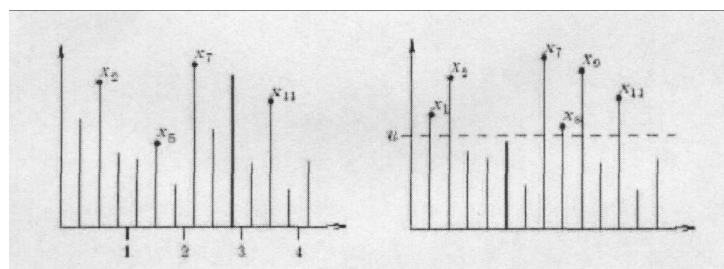
- A. i and iv only
- B. ii, iii, and iv only
- C. i and iii only
- D. ii and iv only

**Answer: A**

**Explanation:** “i” is true. Using the copula approach, we can calculate the structures of correlation between variables separately from the marginal distributions. “iv” is also true. Correlation is a good measure of dependence when the measured variables are distributed as multivariate elliptical.

“ii” is false. The correlation between transformed variables will not always be the same as the correlation between those same variables before transformation. Data transformation can sometimes alter the correlation estimate. “iii” is also false. Correlation is not defined unless variances are finite.

### Key Point: Extreme Value



#### Generalized Extreme Value Distribution (Block Maxima Method)

$$F(x) = e^{-\left(1 + \xi \cdot \frac{x - \mu}{\sigma}\right)^{-1/\xi}}, \quad 1 + \xi \cdot \frac{x - \mu}{\sigma} > 0$$

When  $\xi > 0$ , that is Fréchet distribution, the tails are “heavy”.

When  $\xi = 0$ , that is Gumbel distribution, the tails are “light” as is the case for normal.

When  $\xi < 0$ , that is Weibull distribution, the tails are “lighter”.

#### Generalized Pareto Distribution (Peaks over Threshold)

In this distribution, the tail (or shape) index parameter,  $\xi$ , is the same as it is in GEV distribution.

For the POT approach, the VaR and expected shortfall formulas are as follows:

$$\text{VaR} = u + \frac{\beta}{\xi} \left[ \left[ \frac{n}{N_u} (1 - \text{confidence level}) \right]^{-\xi} - 1 \right]$$

where:

$\xi$  = shape parameter

$\beta$  = scale parameter

u = threshold (in percentage terms)

n = number of observations

$N_u$  = number of observations that exceed threshold

$$\text{ES} = \frac{\text{VaR}}{1-\xi} + \frac{\beta - \xi u}{1-\xi}$$

13. Which of the following statements regarding extreme value theory (EVT) is *incorrect*?

- A. In contrast to conventional approaches for estimating VAR, EVT only considers the tail behavior of the distribution.
- B. Conventional approaches for estimating VAR that assume that the distribution of returns follows a unique distribution for the entire range of values may fail to properly account for the fat tails of the distribution of returns.
- C. EVT attempts to find the optimal point beyond which all values belong to the tail and then models the distribution of the tail separately.
- D. By smoothing the tail of the distribution, EVT effectively ignores extreme events and losses that can generally be labeled outliers.

**Answer: D**

EVT only uses information in the tail, so statement a. is correct. Conventional approaches such as delta-normal VAR assume a fixed p.d.f. for the entire distribution, which may understate the extent of fat tails. So, statement b. is correct. The first step in EVT is to choose a cutoff point for the tail, then to estimate the parameters of the tail distribution, so statement c. is correct. Finally, EVT does not ignore extreme events (as long as they are in the sample).

14. The peaks-over-threshold (POT) approach is used by a firm to apply extreme value theory (EVT) to the distribution of excess losses over a high threshold. The firm estimated the following parameter values: distribution scale parameter = 0.90, distribution shape parameter = 0.15, threshold = 1%, and number of observations that exceed threshold / threshold = 5%. Compute the 1% VaR in percentage terms and the corresponding expected shortfall measure.

- A. VaR = 2.64%, and ES = 3.98%.
- B. VaR = 2.51%, and ES = 3.54%.
- C. VaR = 2.27%, and ES = 3.21%.
- D. VaR = 2.19%, and ES = 3.12%.

**Answer: A**

$$VaR = 1 + \frac{0.9}{0.15} \left[ \left[ \frac{1}{0.05} (1 - 0.99) \right]^{-0.15} - 1 \right] = 2.638\%$$

$$ES = \frac{2.638}{1 - 0.15} + \frac{0.9 - 0.15 \times 1}{1 - 0.15} = 3.98\%$$

15. Which of the following statements about Extreme Value Theory (EVT) and its application to value at risk are true?

- I. EVT extends the Central Limit Theorem to the distribution of the tails of independent, identically distributed random variables drawn from an unknown distribution.
- II. For empirical stock market data, the shape parameter in EVT is negative implying tails that disappear more rapidly than a normal distribution.
- III. EVT can help avoid a shortcoming of the historical simulation method which may have difficulty calculating VaR reliably due to a lack of data in the tails.
- IV. For empirical stock market data, standard value at risk estimates at the 95% confidence level are exceeded more often than 5% of the time and would therefore benefit from the use of extreme value theory.

- A. I and III
- B. II and IV
- C. I, III and IV
- D. III and IV

**Answer: C**

16. You are a quantitative analyst at an insurance company. Given some large losses incurred by the company recently, your boss is interested in determining the expected number of extreme losses per year. As well, your boss is quite certain that the company is now more likely to experience an extreme event than before. Based on the information provided by your boss, to model the frequency and severity of extreme events, which of the following distributions would be most appropriate to use?

- |    | <u>Frequency</u>     | <u>Severity</u>      |
|----|----------------------|----------------------|
| A. | Poisson distribution | Frechet distribution |
| B. | Poisson distribution | Gumbel distribution  |
| C. | Weibull distribution | Frechet distribution |
| D. | Weibull distribution | Gumbel distribution  |

**Answer: A**

**Key Point: Backtesting VAR**



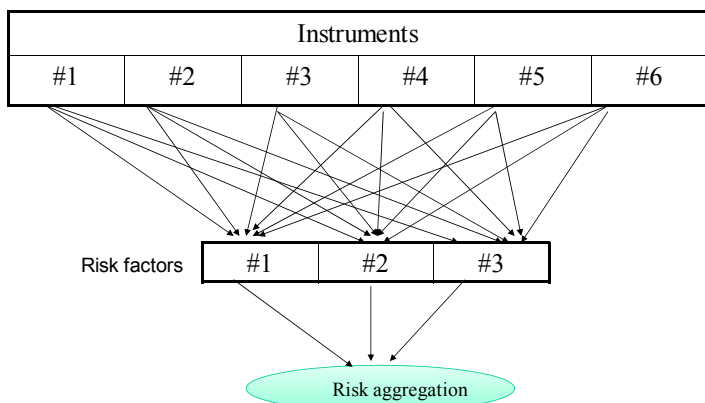
II error. A Type II error is defined as accepting an inaccurate model. If the number of exceptions is less than 2, we reject the model because the calculated LR is greater than 3.84. If we accept the model, we cannot commit a Type I error. A Type I error is defined as rejecting an accurate model.

18. Which of the following statements regarding verification of a VAR model by examining its failure rates is false?
- I. The frequency of exceptions should correspond to the confidence level used for the model.
  - II. According to Kupiec (1995), we should reject the hypothesis that the model is correct if the  $LR > 3.84$ .
  - III. Backtesting VAR models with lower confidence levels is difficult because the number of exceptions is not high enough to provide meaningful information.
  - IV. The range for the number of exceptions must strike a balance between the chances of rejecting an accurate model (a type 1 error) and the chance of accepting an inaccurate model (a type2 error)
- A. I and IV
  - B. II only
  - C. III only
  - D. II and IV

**Answer: C**

Backtesting VAR models with *higher* confidence levels is difficult because the number of exceptions is not high enough to provide meaningful information.

**Key Point: VAR Mapping**



*Three approaches for mapping a fixed income portfolio onto the risk factors.*

- *Principal mapping.* Only the risk associated with the return of principal at the maturity of the bond is mapped. Principal mapping includes only the risk of repayment of the principal amounts.
- *Duration mapping.* The risk of the bond is mapped to a zero-coupon bond of the same

duration. Duration mapping uses the duration of the portfolio to calculate the VAR.

- *Cash flow mapping.* The risk of the bond is decomposed into the risk of each of the bonds' cash flows. Cash flow mapping is the most precise method because we map the present value of the cash flows (face amount discounted at the spot rate for that maturity) onto the risk factors for zeros of the same maturities and include the inter-maturity correlations.

### Mapping Approaches for Linear Derivatives

Delta-normal method:  $VAR(dP) = |-D^*P| \times VAR(dy)$

### Mapping Approaches for Nonlinear Derivatives

Delta-Gamma method:  $VAR(df) = |\Delta| \times VAR(dS) - (1/2) \Gamma \times VAR(dS)^2$

19. An analyst is using the delta-normal method to determine the VaR of a fixed income portfolio. The portfolio contains a long position in 1-year bonds with a \$1 million face value and a 6% coupon that is paid semi-annually. The interest rates on six-month and twelve-month maturity zero-coupon bonds are, respectively, 2% and 2.5%. Mapping the long position to standard positions in the six-month and twelve-month zeros, respectively, provides which of the following mapped positions?

- A. \$30,000 and 1,030,000
- B. \$29,500 and 975,610
- C. \$29,703 and 1,004,878
- D. \$30,300 and 1,035,000

**Answer: C**

The long position is mapped into a combination of market values of the zero-coupon bonds that provide the same cash flows:

$$X_{six} = \frac{30,000}{1 + (0.02/2)} = 29,703 \quad ; \quad X_{twelve} = \frac{1,030,000}{1 + (0.025)} = 1,004,878$$

20. Which of the following can be considered a general risk factor?

- I. Exchange rate
- II. Mortgage-backed securities
- III. Zero-coupon bond
- IV. Interest rate

- A. I only
- B. II and III
- C. III only

D. I and IV

**Answer: D**

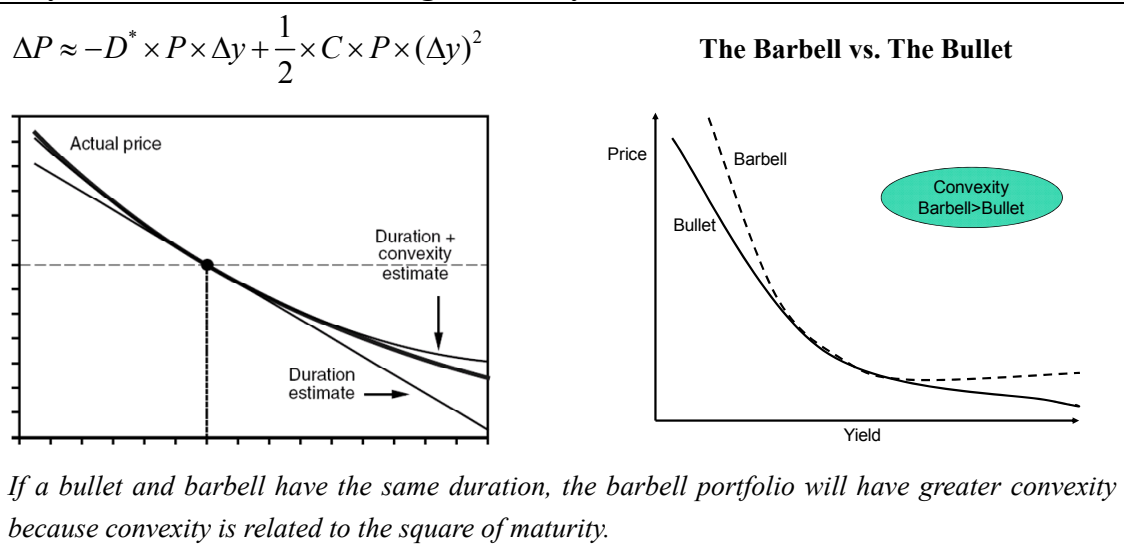
21. Delta-normal VaR will provide accurate estimates for option contracts when:

- A. Deltas are stable
- B. Options are at the money
- C. The correlation matrix is available
- D. The delta-normal method can never be used for option contracts

**Answer: A**

Delta-normal VaR methods will provide accurate estimates of VaR for options only over those ranges in which the deltas of the contracts are stable. Deltas are normally unstable near the money and close to expiration.

**Key Point: Measures of Pricing Sensitivity Based on Parallel Yield Shifts**



22. John Snows portfolio has a fixed-income position with market value of USD 70 million with modified duration of 6.44 years and yielding 6.7% compounded semiannually. If there is a positive parallel shift in the yield curve of 25 basis points, which of the following answers best estimates the resulting change in the value of John’s portfolio?

- A. USD -11,725
- B. USD -1,127,000
- C. USD -1,134,692
- D. USD -1,164,755

**Answer: B**

Explanation:

A: is correct. By definition,  $D_{\text{mod}} = (-1/P) (dP/dy)$ . So as a linear approximation,

$$\Delta P = -D_{\text{mod}} \times P \times \Delta y = -6.44 \times 70\text{million} \times 0.0025 = -1,127,000$$

23. Consider the following three methods of estimating the profit and loss (P&L) of a bullet bond: full repricing, duration (PV01), and duration plus convexity. Rank the methods to estimate the P&L impact of a large negative yield shock from the lowest to the highest.

- A. Duration, duration plus convexity, full repricing
- B. Duration, full repricing, duration plus convexity
- C. Duration plus convexity, duration, full repricing
- D. Full repricing, duration plus convexity, duration

**Answer: A**

24. Which of the following statements are true?

- I. The convexity of a 10-year zero-coupon bond is higher than the convexity of a 10-year, 6% bond.
  - II. The convexity of a 10-year zero-coupon bond is higher than the convexity of a 6% bond with a duration of 10 years.
  - III. Convexity grows proportionately with the maturity of the bond.
  - IV. Convexity is always positive for all types of bonds.
  - V. Convexity is always positive for “straight” bonds.
- A. I only
  - B. I and II only
  - C. I and V only
  - D. II, III, and V only

**Answer: C**

Because convexity is proportional to the square of time to payment, the convexity of a bond is mainly driven by the cash flows far into the future. Answer I. is correct because the 10-year zero has only one cash flow, whereas the coupon bond has several others that reduce convexity. Answer II. is false because the 6% bond with 10-year duration must have cash flows much further into the future, say in 30 years, which will create greater convexity. Answer III is false because convexity grows with the square of time. Answer IV. is false because some bonds, for example MBSs or callable bonds, can have negative convexity. Answer V. is correct because convexity must be positive for coupon-paying bonds.



25. A bond portfolio consists of five bonds:

- Bond 1: 5%, annual-pay bond with a 10-year maturity and a yield of 4.5%.
- Bond 2: 5%, semiannual-pay bond with a 10-year maturity and a yield of 4.5%.
- Bond 3: A zero-coupon bond with a 10-year maturity and a yield of 4.5%.
- Bond 4: 4%, semiannual-pay bond with a 10-year maturity and a yield of 4.5%.
- Bond 5: 5%, annual-pay bond with a 10-year maturity and a yield of 5.5%.

Which of the following statements about these bonds is Correct?

- A. Bond 1 has a shorter duration than Bond 2.
- B. The Macaulay duration of Bond 3 is five years.
- C. Bond 4 has a shorter duration than Bond 2.
- D. The DV01 of Bond 5 is lower than the DV01 of Bond 1.

**Answer: D**

Choice D is correct. Increasing the yield will lower the DV01. Since Bond 5 has a higher yield than Bond 1, it must have a lower DV01. Choice B is incorrect. The Macaulay duration of a zero-coupon bond will be equal to its maturity Choices A and C are incorrect. All else equal, a semiannual-pay bond will have a shorter duration than an annual-pay bond, so Bond 2 has a shorter duration than Bond 1. A premium bond will have a shorter duration than a discount bond, so Bond 2 will have a shorter duration than Bond 4.

26. Given the following bond portfolios:

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Which of the following statements is correct?

- A. Portfolio 1 is a barbell portfolio.
- B. Portfolio 2 is a bullet portfolio.
- C. It is impossible for Portfolios 1 and 2 to have the same duration.
- D. Portfolio 2 will have greater convexity than Portfolio 1.

**Answer: D**

Since Portfolio 2 has more long-term bonds than short-term bonds and since convexity is related to the square of maturity, Portfolio 2 will have greater convexity. The other statements are incorrect. Portfolio 1 is a bullet portfolio (concentrated in intermediate maturities), and Portfolio 2 is a barbell. It is possible for a bullet and a barbell to have the same duration. In fact, adding the duration contribution of both portfolios gives a duration value of 8.15.

### **Key Point: Key Rate and Key Rate Duration and bucket exposure**

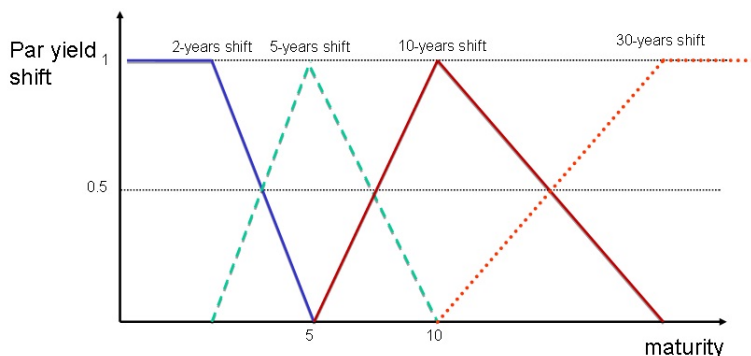
- Duration assumes a parallel shift in the yield curve.
- Key rate duration addresses nonparallel shifts in the yield curve by allowing for changes in all rates to be determined by changes in key rates.
- Changes in each key rate will affect the term of the previous and subsequent key rates in a linear

fashion.

*Key rate 01 (\$)*: dollar change of a one-basis-point shift around each key rate on the value of the security.

*Key rate duration*: interpreted as the approximate percentage change in the value of a bond or bond portfolio in response to a 100-basis-point change in a given key rate, holding all other rates constant. The sum of the key rate durations for a bond will equal the effective duration of that bond.

$$\text{key rate duration}_{t\text{-year shift}} = \frac{\text{key rate 01 (year } t)}{\text{initial value}} \times 10,000$$



### Key Rate Shift vs. Bucket Shift Approaches

The key rate and bucket rate methods differ from the number of inputs used in their analyses. Key rates focus on a specified number of rates, while bucket shifting focuses on effects specific to a certain region on the maturity spectrum.

27. The main problem associated with using single-factor approaches to hedge interest rate risk is:
- no method can hedge interest rate risk.
  - single-factor models assume mean-reversion between one short-term and one long-term rate.
  - single-factor models assume effects across the entire curve dictated by one rate.
  - single-factor models assume risk-free securities have credit exposure.

**Answer: C**

Single-factor models assume that any change in any rate across the maturity spectrum can indicate changes across any other portion of the curve.

28. You are using key rate shifts to model the term structure of interest rates. For key rates, you have chosen the 3-year, 8-year, and 25-year yields. The key rate changes that will have an impact on the yield on a 15-year bond are:
- 8-year and 25-year only
  - 8-year only
  - 25-year only
  - 3-year, 8-year, and 25-year

**Answer: A**

The adjacent key rates will have an impact on the 15-year bond yield.

29. Assume you own a security with a 2-year key rate exposure of \$4.78, and you would like to hedge your position with a security that has a corresponding 2-year key rate exposure of 0.67 per \$ 100 face value. What amount of face value would be used to hedge the 2-year exposure?
- A. \$478
  - B. \$239
  - C. \$713
  - D. \$670

**Answer: C**

30. A fixed income hedge fund manager is preparing a report for junior analysts with the firm that addresses key rate and bucket exposures. Which of the following statements in the report is correct?
- A. The key rate shift technique is an approach to analyze parallel shifts in the yield curve that allows for changes in all rates to be determined by changes given in key rates.
  - B. Key rate duration can be interpreted as the approximate percentage change in the value of a bond portfolio in response to a 1 basis point change in a given key rate.
  - C. Immunization strategies are equally effective for small and large changes in interest rates.
  - D. A major difference between key rate shift and bucket shift approaches is the number of interest rate factors used in the analysis.

**Answer: D**

A major difference between key rate shift and bucket shift approaches is the number of interest rate factors used in the analysis. Key rate duration can be interpreted as the approximate percentage change in the value of a bond portfolio in response to a 100 basis point change in a given key rate. The key rate shift technique is an approach to analyze *nonparallel* shifts in the yield curve that allows for changes in all rates to be determined by changes given in key rates. Immunization strategies *may not* be effective for dramatic large changes in interest rates.

**Key Point: Interest Rate Tree (Binomial) Model**

Using backward induction, the value of a bond at a given node in a binomial tree is the average of the present values of the two possible values from the next period. The appropriate discount rate is the forward rate associated with the node under analysis.

There are three basic steps to valuing an option on a fixed-income instrument using a binomial tree:

*Step 1:* Price the bond value at each node using the projected interest rates.

*Step 2:* Calculate the intrinsic value of the derivative at each node at maturity.

*Step 3:* Calculate the expected discounted value of the derivative at each node using the risk-neutral probabilities and work backward through the tree.

**31.** A European put option has two years to expiration and a strike price of \$101.00. The underlying is a 7% annual coupon bond with three years to maturity. Assume that the risk-neutral probability of an up move is 0.76 in year 1 and 0.60 in year 2. The current interest rate is 3.00%. At the end of year 1, the rate will either be 5.99% or 4.44%. If the rate in year 1 is 5.99%, it will either rise to 8.56% or rise to 6.34% in year 2. If the rate in one year is 4.44%, it will either rise to 6.34% or rise to 4.70%. The value of the put option today is closest to:

- A. \$1.17
- B. \$1.30
- C. \$1.49
- D. \$1.98

**Answer: A**

This is the same underlying bond and interest rate tree as in the call option example from this topic. However, here we are valuing a put option.

The option value in the upper node at the end of year 1 is computed as:

$$\frac{(\$2.44 \times 0.6) + (\$0.38 \times 0.4)}{1.0599} = \$1.52$$

The option value in the lower node at the end of year 1 is computed as:

$$\frac{(\$0.38 \times 0.6) + (\$0.00 \times 0.4)}{1.0444} = \$0.22$$

The option value today is computed as:

$$\frac{(\$1.52 \times 0.76) + (\$0.22 \times 0.24)}{1.0300} = \$1.17$$

### Key Point: Constant Maturity Treasury Swap

An agreement to swap a floating rate for a Treasury rate, such as the 10-year rate.

**32.** A constant maturity Treasury (CMT) swap pays  $(\$1,000,000/2) \times (y_{\text{CMT}} - 9\%)$  every six months. There is a 70% probability of an increase in the 6-month spot rate and a 60% probability of an increase in the 1-year spot rate. The rate change in all cases is 0.50% per period, and the initial  $y_{\text{CMT}}$  is 9%. What is the value of this CMT swap?

- A. \$2,325
- B. \$2,229
- C. \$2,429
- D. \$905

**Answer: A**

A The payoff in each period is  $(\$1,000,000 / 2) \times (y_{\text{CMT}} - 9\%)$ . For example, the 1-year payoff of \$5,000 in the figure below is calculated as  $(\$1,000,000 / 2) \times (10\% - 9\%) = \$5,000$ . The other numbers in the year one cells are calculated similarly.

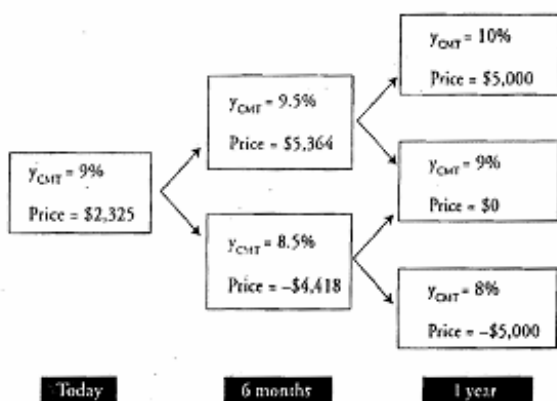
In six months, the payoff if interest rates increase to 9.50% is  $(\$1,000,000 / 2) \times (9.5\% - 9.0\%) = \$2,500$ . Note that the price in this cell equals the present value of the probability weighted 1-year values plus the 6-month payoff:

$$V_{6 \text{ months}, U} = \frac{(\$5,000 \times 0.6) + (\$0 \times 0.4)}{1 + \frac{0.095}{2}} + \$2,500 = \$5,363.96$$

The other cell value in six months is calculated similarly and results in a loss of \$4,418.47.

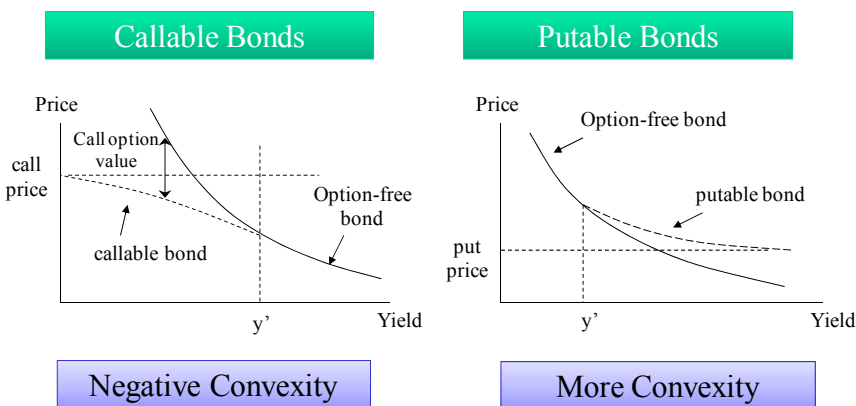
The value of the CMT swap today is the present value of the probability weighted 6-month values:

$$V_0 = \frac{(\$5,363.96 \times 0.7) + (-\$4,418.47 \times 0.3)}{1 + \frac{0.09}{2}} = \$2,324.62$$



Thus the correct response is A. The other answers are incorrect because they do not correctly discount the future values or omit the 6-month payoff from the 6-month values.

### Key Point: Bonds with Embedded Options



33. Immunization is the process of offsetting the effects of interest-rate changes on the value of assets and liabilities. Coverage of liabilities with significant convexity may be more effectively matched with a:

A. Bullet portfolio with little convexity.

- B. Callable bond portfolio, especially in a declining-rate environment.
- C. Mortgage portfolio, especially in a highly volatile rate environment.
- D. Barbell portfolio with positive convexity.

**Answer: D**

Barbell portfolios usually contain substantial convexity, which can be used to offset changes in liabilities not met with duration matches.

34. Which of the following statements about callable bonds compared to non-callable bonds is false?
- A. They have less price volatility.
  - B. They have negative convexity.
  - C. Capital gains are capped as yields rise.
  - D. At low yields, reinvestment rate risk rises.

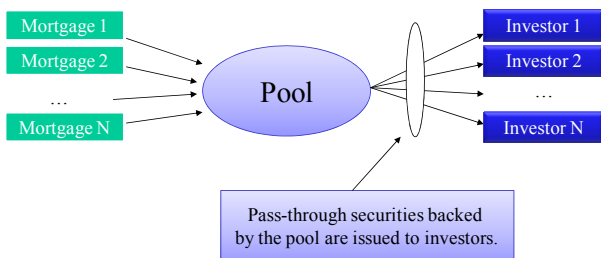
**Answer: C**

Callable bonds have the following characteristics:

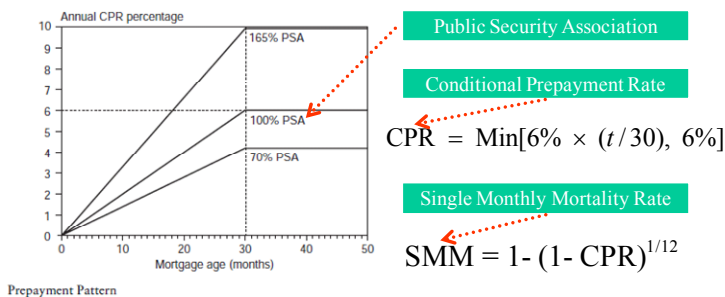
- Less price volatility;
- Negative convexity;
- Capital gains are capped as yields fall;
- Exhibit increased reinvestment rate risk when yields fall.

**Key Point: Mortgage and Mortgage Market**

**Mortgage Pass-Through Securities:**



**Prepayment Speeds:**



35. If a pool of mortgage loans begins the month with a balance of \$10,500,000, has a scheduled principal payment of \$54,800, and ends the month with a balance of \$9,800,000, what is the CPR for this month?

- A. 6.18%
- B. 42.24%
- C. 53.47%
- D. 66.67%

**Answer: C**

We use the following formulas:  $SMM = (\text{prepayment}/\text{beg. bal} - \text{scheduled principal payment})$  and  $(1 - SMM)^{12} = (1 - CPR)$ .

Prepayment = actual payment - scheduled payment =  $(\$10,500,000 - \$9,800,000) - \$54,800 = \$700,000 - \$54,800 = \$645,200$

so:  $\$645,200/(\$10,500,000 - \$54,800) = 0.06177$  and  $CPR = 1 - (1 - 0.06177)^{12} = 0.5347 = 53.47\%$

36. How would you describe the typical price behavior of a low premium mortgage pass-through security?
- A. It is similar to a U.S. Treasury bond.
  - B. It is similar to a plain-vanilla corporate bond.
  - C. When interest rates fall, its price increase would exceed that of a comparable duration U.S. Treasury bond.
  - D. When interest rates fall, its price increase would lag that of a comparable duration U.S. Treasury bond.

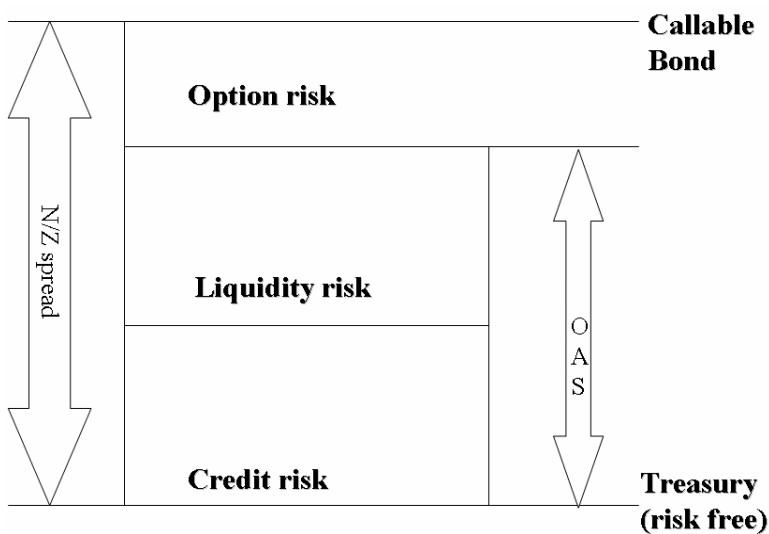
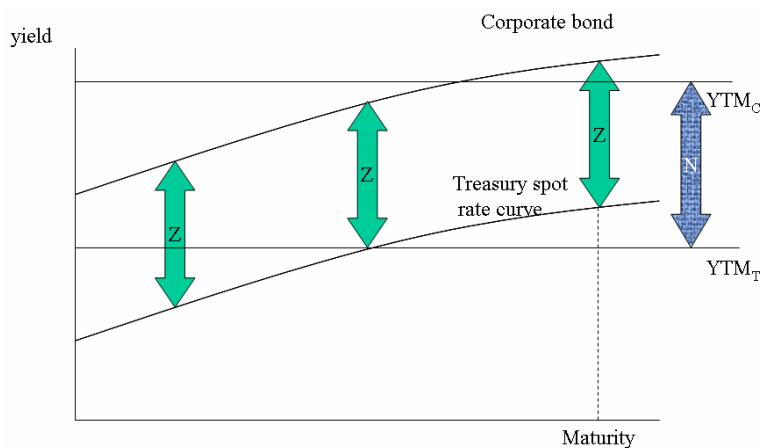
**Answer: D**

MBSs are unlike regular bonds, Treasuries, or corporates, because of their negative convexity. When rates fall, homeowners prepay early, which means that the price appreciation is less than that of comparable duration regular bonds.

**Key Point: Mortgage-Backed Securities**

- Nominal spread
- Zero-volatility spread
- Option-adjusted spread (OAS):  $\text{Option cost} = Z\text{-spread} - \text{OAS}$

	Description	Character
Nominal spread	= Bond yield to maturity – yield on a comparable-maturity government treasury security $P_{\text{market}} = \frac{CF_1}{(1+R+N)^1} + \frac{CF_2}{(1+R+N)^2} + \dots$	Use a single interest rate to discount each cash flow.
Z-spread	$P_{\text{market}} = \frac{CF_1}{(1+R_1+Z)^1} + \frac{CF_2}{(1+R_2+Z)^2} + \dots$	Assume the interest rate volatility is zero.
OAS	OAS=Z-spread – Option cost $P_{\text{market}} = \frac{CF_1}{(1+R_1+OAS)^1} + \frac{CF_2}{(1+R_2+OAS)^2} + \dots$	



- Contraction risk and Extension risk
- CMO and PCA



Special-Purpose Vehicle

Asset cash flows

Pool

Tranche A

Tranche B

Tranche C

Tranche Z

Cash flow

Tranching

Tranche		Prepayment risk
PAC Tranches	A	LOW
	B	
	C	
Support tranche (may lead to broken or busted PAC)		HIGH

➤ Stripped MBS

- Principal-only strips (PO)
- Interest-only strips (IO)

Market price

Market yield

MBS

Interest-only (IO)

Principal-only (PO)

Creating an IO and PO from an MBS

➤ Effective Duration:  $\frac{P_- - P_+}{2 \times P_0 \times \Delta y}$

➤ Effective Convexity:  $\frac{P_- + P_+ - 2 \times P_0}{P_0 \times \Delta y^2}$

37. Which of the following about the duration of a mortgage-backed, interest-only security (IO) is correct?

- A. An IO has positive duration.
- B. An IO has negative duration.
- C. An IO has exactly the same duration as a mortgage-backed security (MBS) with the same coupon.
- D. An IO has exactly the same duration as a mortgage-backed, principal-only security stripped off the same MRS.

**Answer: B**

**Explanation:** The IO holder benefits from rising rates. If rates are rising, prepays slow. Thus, IOs have negative duration and can be used for hedging purposes. An IO's price moves in the same direction as interest rate changes, implying negative duration. An MBS has positive duration, as it is inversely proportional to interest rate changes. Likewise, a PO has positive duration, as it is inversely proportional to interest rate changes.

38. Mortgage-backed securities (MBS) are a class of securities where the underlying is a pool of mortgages. Assume that the mortgages are insured, so that they do not have default risk. The mortgages have prepayment risk because the borrower has the option to repay the loan early (at any time) usually due to favorable interest rate changes. From an investor's point of view, a mortgage-backed security is equivalent to holding a long position in a non-prepayable mortgage pool and which of the following?
- A. A long American call option on the underlying pool of mortgages.
  - B. A short American call option on the underlying pool of mortgages.
  - C. A short European put option on the underlying pool of mortgages.
  - D. A long American put option on the underlying pool of mortgages.

**Answer: B**

Explanation: Prepayment risk is equivalent to an American call option because the borrower can repay at any time and the position is short because the option lies with the borrower.

39. With LIBOR at 4%, a manager wants to increase the duration of his portfolio. Which of the following securities should he acquire to increase the duration of his portfolio the most?
- A. A 10-year reverse floater that pays  $8\% - \text{LIBOR}$ , payable annually
  - B. A 10-year reverse floater that pays  $12\% - 2 \times \text{LIBOR}$ , payable annually
  - C. A 10-year floater that pays LIBOR, payable annually
  - D. A 10-year fixed rate bond carrying a coupon of 4% payable annually

**Answer: B**

The duration of a floater is about zero. The duration of a 10-year regular bond is about nine years. The first reverse floater has a duration of about  $2 \times 9 = 18$  years, the second,  $3 \times 9 = 27$  years.

40. Which of the following concerning the role of a support tranche in a planned amortization class (PAC) collateralized mortgage obligation (CMO) is (are) correct?
- A. The purpose of a support tranche is to provide prepayment protection for one or more PAC tranches.
  - B. Support tranches are exposed to high levels of prepayment risk.
  - C. If prepayments are too low to maintain the PAC schedule, the shortfall is provided by the support tranche.
  - D. As prepayments occur, the amount of prepayment protection provided by the support tranche increases.
- 
- A. I only
  - B. I, II and IV

- C. I, II and III
- D. II, III and IV

**Answer: C**

Support tranches are included in a structure with a PAC specifically to provide prepayment protection for the PAC tranches. Since the support tranches receive prepayments before the PAC tranches, they are exposed to high levels of prepayment risk. Also, if prepayments are slower than expected, cash flows are diverted from the support tranches to keep the PAC tranches on schedule. Note that as prepayments occur and the support tranches gets closer to being paid off, the support tranche will have less capacity for further prepayments and will therefore provide less prepayment protection.

41. Consider a collateralized mortgage obligation (CMO) structure with one planned amortization class (PAC) tranche and one support tranche outstanding. Also, assume that the prepayment spread is higher than the upper collar on the PAC. Which of the following statements is most accurate? The:
- A. PAC tranche has no risk of prepayments
  - B. Average life of the support tranche will contract
  - C. Average life of the PAC tranche will extend
  - D. Average life of the support tranche will extend

**Answer: B**

If the prepayment spread is faster than the PAC collar, the support tranche receives a higher level of prepayments (so that the PAC tranche remains at the upper collar of the PAC). The average life of the support tranche will contract (shorten). The PAC tranche *could* receive higher prepayments if eventually the support tranche is fully repaid its principal (i.e., a busted PAC). However, the question says that the support tranche is still outstanding, which means that hasn't happened yet.

42. Jack recently completed a Monte Carlo simulation analysis of a CMO tranche. Jack's analysis includes six equally weighted paths, with the present value of each calculated using four different discount rates, which are shown in the following table. If the actual market price of the CMO tranche being valued is 70.17, what is the tranche's option-adjusted spread (OAS)?

Representative Path	PV if Spread is 50 bps	PV if Spread is 60 bps	PV if Spread is 70 bps	PV if Spread is 75 bps
1	70	68	66	65
2	73	70	68	66
3	68	66	64	63
4	71	69	68	67
5	77	75	73	71
6	75	73	71	70

- A. 50 basis points

- B. 60 basis points
- C. 70 basis points
- D. 75 basis points

**Answer: B**

The problem tells us that the market price of the CMO tranche is 70.17. The OAS is the spread that is added to the interest rates along the interest rate path that makes the market and the theoretical value equal. The price of the CMO will be the weighted average of the values of each interest path. Because we are told in the problem that the paths are equally weighted, we simply find the arithmetic average for each path and choose the theoretical value that equals the market price. In this case, the average of the 60bp spread column is:  $\frac{68 + 70 + 66 + 69 + 75 + 73}{6} = \frac{421}{6} = 70.17$

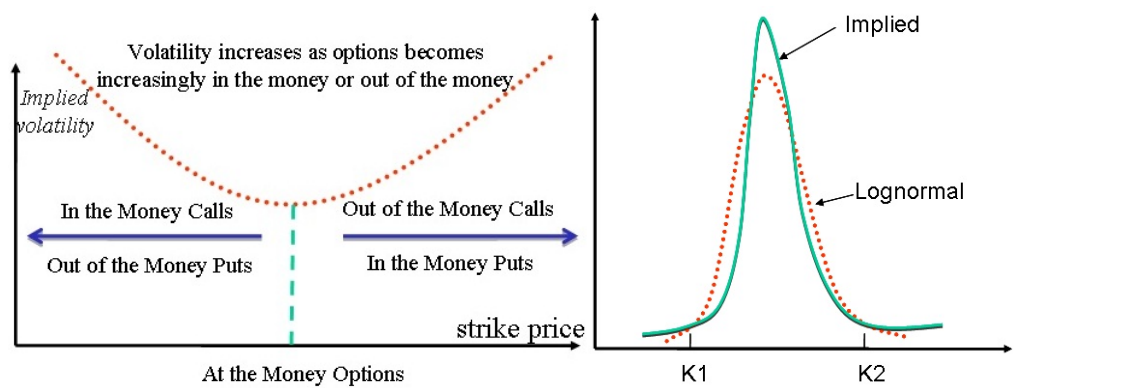
The OAS must be 60 bp.

**Key Point: Volatility Smile**

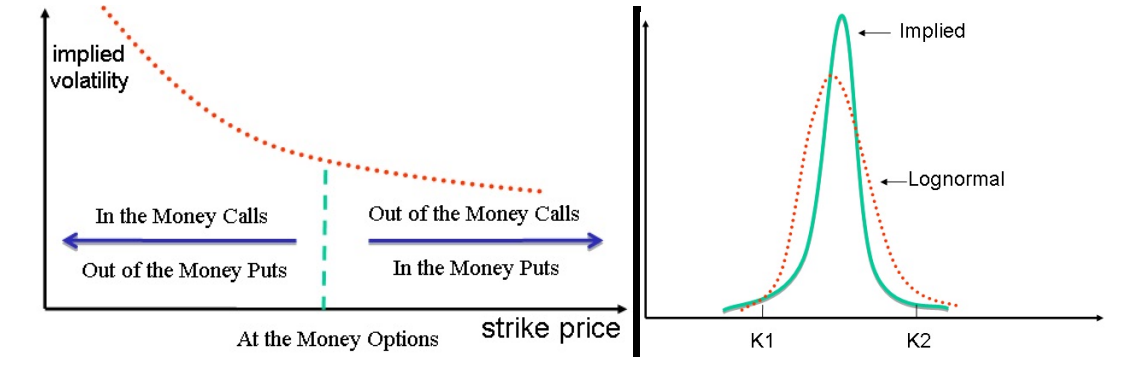
Put-call parity indicates that the deviation between market prices and Black-Scholes-Merton prices will be equivalent for calls and puts. Hence, implied volatility will be the same for calls and puts.

$$P_{BS} - P_{mkt} = C_{BS} - C_{mkt}$$

*For foreign exchange options:*



*For stock options:*



43. The Chief Risk Officer of Martingale Investments Group is planning a change in methodology for some of the risk management models used to estimate risk measures. His

aim is to move from models that use the normal distribution of returns to models that use the distribution of returns implied by market prices. Martingale Group has a large long position in the German equity stock index DAX which has a volatility smile that slopes downward to the right. How will the change in methodology affect the estimate of expected shortfall (ES)?

- A. ES with the updated models will be larger than the old estimate.
- B. ES with the updated models will be smaller than the old estimate.
- C. ES will remain unchanged.
- D. Insufficient information to determine.

**Answer: A**

**Explanation:** A volatility smile is a common graphical shape that results from plotting the strike price and implied volatility of a group of options with the same expiration date. Since the volatility smile is downward sloping to the right, the implied distribution has a fatter left tail compared to the lognormal distribution of returns. This means that an extreme decrease in the DAX has a higher probability of occurrence under the implied distribution than the lognormal. The ES will therefore be larger when the methodology is modified.

44. With all other things being equal, a risk monitoring system that assumes constant volatility for equity returns will understate the implied volatility for which of the following positions by the largest amount:
- A. Short position in an at-the-money call
  - B. Long position in an at-the-money call
  - C. Short position in a deep in-the-money call
  - D. Long position in a deep in-the-money call

**Answer: D**

A plot of the implied volatility of an option as a function of its strike price demonstrates a pattern known as the volatility smile or volatility skew. The implied volatility decreases as the strike price increases. Thus, all else equal, a risk monitoring system which assumes constant volatility for equity returns will understate the implied volatility for a long position in a deep-in-the-money call.

45. Which of the following regarding equity option volatility is true?
- A. There is higher implied price volatility for away-from-the-money equity options.
  - B. “Crashophobia” suggests actual equity volatility increases when stock prices decline.
  - C. Compared to the lognormal distribution, traders believe the probability of large down movements in price is similar to large up movements.
  - D. Increasing leverage at lower equity prices suggests increasing volatility.

**Answer: D**

There is higher implied price volatility for low strike price equity options. “Crashophobia” is based on the idea that large price declines are more likely than assumed in Black-Scholes-Merton

prices, not that volatility increases when prices decline. Compared to the lognormal distribution, traders believe the probability of large down movements in price is higher than large up movements. Increasing leverage at lower equity prices suggests increasing volatility.

46. You are asked to mark to market a book of plain vanilla stock options. The trader is short deep out-of-the-money options and long at-the-money options. There is a pronounced smile for these options. The trader's bonus increases as the value of his book increases. Which approach should you use to mark the book?
- Use the implied volatility of at-the-money options because the estimation of the volatility is more reliable.
  - Use the average of the implied volatilities for the traded options for which you have data because all options should have the same implied volatility with Black-Scholes and you don't know which one is the right one.
  - For each option, use the implied volatility of the most similar option traded on the market.
  - Use the historical volatility because doing so corrects for the pricing mistakes in the option market.

**Answer: C**

Explanation: The prices obtained with C are the right ones because they correspond to prices at which you could sell or buy the options.

47. The market price of a European call is \$3.00 and its Black-Scholes price is \$3.50. The Black-Scholes price of a European put option with the same strike price and time to maturity is \$2.00. What should the market price of this option be?
- \$1.50
  - \$2.00
  - \$1.00
  - \$0.50

**Answer: A**

Based on the put-call parity,  $c_{bs} + Ke^{-rT} = p_{bs} + S_0e^{-qT}$  and  $c_{mkt} + Ke^{-rT} = p_{mkt} + S_0e^{-qT}$ . We can know that:  $c_{bs} - c_{mkt} = p_{bs} - p_{mkt}$ . And  $c_{bs} = \$3.50$ ,  $c_{mkt} = \$3.00$ ,  $p_{bs} = \$2.00$ . So  $p_{mkt} = \$1.50$ . Choose A

### Key Point: Exotic options

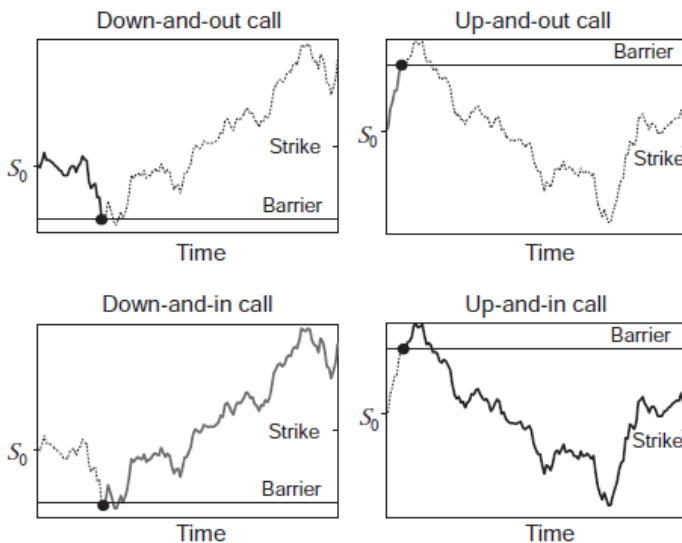
**Compound option:** option on another option.

- Call on a call:* right to buy a call option at a set price for a set period of time.
- Call on a put:* right to buy a put option at a set price for a set period of time.
- Put on a call:* right to sell a call option at a set price for a set period of time.
- Put on a put:* right to sell a put option at a set price for a set period of time.

**Chooser option:** owner chooses whether option is call or put after initiation.

**Barrier option:** payoff and existence depend on price reaching a certain barrier level.

- *Down-and-out call (put):* ceases to exist if the underlying asset price hits the barrier level, which is set below the current stock value.
- *Down-and-in call (put):* only comes into existence if the underlying asset price hits the barrier level, which is set below the current stock value.
- *Up-and-out call (put):* ceases to exist if the underlying asset price hits a barrier level, which is set above the current stock value.
- *Up-and-in call (put):* only comes into existence if the underlying asset price hits the above-current stock-price barrier level.



Paths for Knock-Out and Knock-In Call Options

**Binary option:** pay either nothing or a fixed amount.

- *Cash-or-nothing call:* a fixed amount,  $Q$ , is paid if the asset ends up above the strike price.  $N(d_2)$  is the probability of the asset price being above the strike price, the value of a cash-or-nothing call is equal to  $Qe^{-rT} N(d_2)$
- *Asset-or-nothing call:* pays the value of the stock when the contract is initiated if the stock price ends up above the strike price at expiration. The corresponding value for this option is:  $S_0 e^{-qT} N(d_1)$ . (as equivalent strike price equal to zero  $c = S_0 e^{-qT} N(d_1) - Ke^{-rT} N(d_2)$  )

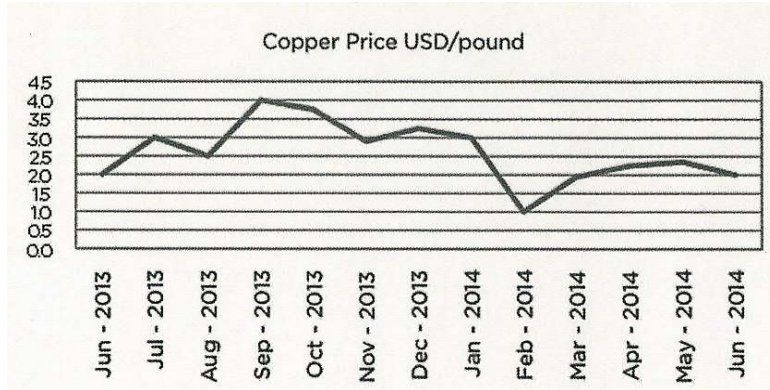
**Lookback option:** payoff depends on the maximum (call) or minimum (put) value of the underlying asset over the life of the option. Can be fixed or floating depending on the specification of a strike price.

**Shout option:** owner receives intrinsic value of option at shout date or expiration, whichever is greater.

**Asian option:** payoff depends on average of the underlying asset price over the life of the option; less volatile than standard option.

**Basket options:** options to purchase or sell baskets of securities. These baskets may be defined specifically for the individual investor and may be composed of specific stocks, indices, or currencies. Any exotic options that involve several different assets are more generally referred to as **rainbow options**. (one example is the bond futures contract traded on the CBOT (described in Level I). The party with the short position is allowed to choose between a large number of different bonds when making delivery.)

48. In an effort to hedge some of your portfolio’s commodity exposure, you purchased a look-back put on 100,000 pounds of copper for the period from June 30, 2009 through June 30, 2010. The price of copper over this period is shown in the chart below. What was the payoff at expiration of this option?



- A. USD 0
- B. USD 100,000
- C. USD 200,000
- D. USD 300,000

**Answer: C**

**Explanation:** Look-back options are options which the holder can buy/sell the underlying asset at the lowest/highest price achieved during the life of the option. A put look-back option is the option to sell at the highest price. The payoffs from look-back options depend on the maximum or minimum price reached during the life of the option.

The payoff of a look-back put is the difference between the maximum price of the underlying asset over the time period covered by the option (USD 4), less the price at expiration (USD 2):

$$100,000 * (USD 4 - USD 2) = USD 200,000$$

49. A 1-year forward contract on a stock with a forward price of USD 100 is available for USD 1.50. The table below lists the prices of some barrier options on the same stock with a maturity of 1 year and strike of USD 100. Assuming a continuously compounded risk-free rate of 5% per year what is the price of a European put option on the stock with a strike of USD 100.

Option	Price
Up-and-in barrier call, barrier USD 95	USD 5.21
Up-and-out barrier call, barrier USD 95	USD 1.40
Down-and-in barrier put, barrier USD 80	USD 3.5

- A. USD 2.00
- B. USD 4.90



- C. USD 5.11
- D. USD 6.61

**Answer: C**

Explanation:

The sum of the price of up-and-in barrier call and up-and-out barrier call is the price of an otherwise the same European call. The price of the European call is therefore USD 5.21 + USD 1.40 = USD 6.61. The put-call parity relation gives Call - put = Forward (with same strikes and maturities). Thus 6.61 - put = 1.50. Thus put = 6.61 - 1.50 = 5.11

50. You are an institutional portfolio manager. One of your clients is very interested in the flexibility of options but expresses great concern about the high cost of some of them. In general, which of the following options would be the *least* costly to purchase?
- A. Shout options
  - B. American options
  - C. Lookback options
  - D. Bermudan options

**Answer: D**

Bermudan options may be exercised early (like American options) but exercise is restricted to certain dates. Therefore, the restriction suggests that Bermudan options must be cheaper than American options.

Choice A is incorrect because a shout option is a European option where the holder has a valuable right to “shout” to the writer at one time during the option’s life. At the end of the option’s life, the payoff is the greater of the payoff from the European option and the payoff at the time of the shout. The added upside potential makes this option more expensive. Choice C is incorrect because the holder of a lookback option is guaranteed the most favorable underlying price during the life of the option, so it makes this option one of the most expensive to purchase.

51. You believe that a stock will increase in price and would like to buy a call option. You would like to choose the date during the option’s term when the option payoff is determined. However, if the option payoff is greater at the option’s maturity, you want to be paid this value. What type of option should you buy?
- A. Chooser option
  - B. Compound option
  - C. Shout option
  - D. Asian option

**Answer: C**

The shout option allows the buyers to choose the date when he “shouts” to the option seller that the intrinsic value should be determined. At expiration, the option buyer receives the maximum of

the shout value or the intrinsic value at expiration.

Choice A is incorrect because a chooser option buyer chooses whether the option is a put option or a call option, after a certain period of time has elapsed.

Choice B is incorrect because a compound option is an option on an option.

Choice D is incorrect because an Asian option based the payoff on average stock prices.

52. Looking at a risk report. Mr.Woo finds that the options book of Ms. Yu has only long positions and yet has a negative delta. He asks you to explain how that is possible. What is a possible explanation?
- A. The book has a long position in up-and-in call options.
  - B. The book has a long position in binary options.
  - C. The book has a long position in up-and-out call options.
  - D. The book has a long position in down-and-out call options.

**Answer: C**

Explanation: As the underlying assets' price increases the up-and-out call options become more vulnerable since they will cease to exist when the barrier is reached. Hence their price decreases. This is negative delta.

53. Of the following options, which one does not benefit from an increase in the stock price when the current stock price is \$100 and the barrier has not yet been crossed:
- A. A down-and-out call with out barrier at \$90 and strike at \$110
  - B. A down-and-in call with in barrier at \$90 and strike at \$110
  - C. An up-and-in put with barrier at \$110 and strike at \$100
  - D. An up-and-in call with barrier at \$110 and strike at \$100

**Answer: B**

A down-and-out call where the barrier has not been touched is still alive and hence benefits from an increase in  $S$ , so a. is incorrect. A down-and-in call only comes alive when the barrier is touched, so an increase in  $S$  brings it away from the barrier. This is not favorable, so b. is correct. An up-and-in put would benefit from an increase in  $S$  as this brings it closer to the barrier of \$110, so c. is not correct. Finally, an up-and-in call would also benefit if  $S$  gets closer to the barrier.

54. You have a long position in a digital call option — an option that is also called cash-or-nothing – on shares in Global Enterprises. The digital call has a strike price of USD 20 with one year remaining to expiration. Assume that the shares currently trade at USD 22 and annual return volatility of Global Enterprises shares is 15%. Which of the following sensitivities would be associated with this option?

- I. Delta is positive
- II. Gamma is positive
- III. Vega is negative
- IV. Vega is positive

Which statements are true?

- A. I and III
- B. IV only
- C. I, II, and IV
- D. II and III

**Answer: A**

Explanation: A call spread replicates a cash-or-nothing option. Such long call spread is constituted by a long call  $C_1$  with a strike  $K - \epsilon$  and a short call  $C_2$  with a strike  $K + \epsilon$  where  $\epsilon$  is small. The strategy is market bullish, the delta is always positive so I is true. Furthermore, the Vega and gamma can be positive or negative depending on the spot level. When the underlying price is bigger than the strike price, the Vega is negative and the gamma as well corresponding to  $C_2$ 's Greeks. So, II is wrong and III is true.

### Key Point: Term Structure Models

**Model 1:** assumes no drift and that interest rates are normally distributed:

$$dr = \sigma d\omega$$

**Model 2:** adds a positive drift term to Model 1 that can be interpreted as a positive risk premium associated with longer time horizons:

$$dr = \lambda dt + \sigma d\omega$$

where:  $\lambda$  = interest rate drift

**Ho-Lee Model:** generalizes drift to incorporate time-dependency:

$$dr = \lambda(t)dt + \sigma d\omega$$

**Vasicek Model:** assumes a mean-reverting process for short-term interest rates:

$$dr = k(\theta - r)dt + \sigma d\omega$$

where:

$k$  = a parameter that measures the speed of reversion adjustment.

$\theta$  = long-run value of the short-term rate assuming risk neutrality.

$r$  = current interest rate level.

**Model 3:** assigns a specific parameterization of time-dependent volatility:

$$dr = \lambda(t)dt + \sigma e^{-\alpha t} d\omega$$

where:

$\sigma$  = volatility at  $t = 0$ , which decreases exponentially to 0 for  $\alpha > 0$

**Cox-Ingersoll-Ross (CIR) Model:** mean-reverting model with constant volatility,  $\sigma$ , and basis-point volatility,  $\sigma\sqrt{r}$ , that increases at a decreasing rate:

$$dr = k(\theta - r)dt + \sigma\sqrt{r}d\omega$$

**Model 4 (lognormal model):** yield volatility,  $\sigma$ , is constant, but basis-point volatility,  $\sigma_r$ , increases with the level of the short-term rate. There are two lognormal models of importance:

- Lognormal with deterministic drift;

$$d[\ln(r)] = a(t)dt + \sigma d\omega$$

- Lognormal with mean reversion.

$$d[\ln(r)] = k(t)[\ln\theta(t) - \ln(r)]dt + \sigma(t)d\omega$$

55. John Jones, FRM, is discussing the appropriate usage of mean-reverting models relative to no-drift models, models that incorporate drift, and Ho-Lee models. Jones makes the following statements:

Statement 1: Both Model 1 (no drift) and the Vasicek model assume parallel shifts from changes in the short-term rate.

Statement 2: The Vasicek model assumes decreasing volatility of future short-term rates while Model 1 assumes constant volatility of future short-term rates.

Statement 3: The constant drift model (Model 2) is a more flexible model than the Ho-Lee model.

How many of his statements are correct?

- A. 0
- B. 1
- C. 2
- D. 3

**Answer: B**

Only statement 2 is correct. The Vasicek model implies decreasing volatility and non-parallel shifts from changes in short-term rates. The Ho-Lee model is actually more general than Model 2 (the no drift and constant drift models are special cases of the Ho-Lee model).

56. Using Model 1, assume the current short-term interest rate is 5%, annual volatility is 80bps, and  $d\omega$ , a normally distribution random variable with mean 0 and standard deviation  $\sqrt{dt}$ , has an expected value of zero. After one month, the realization of  $d\omega$  is -0.5. What is the change in the spot rate and the new spot rate?

- |    | Change in Spot | New Spot Rate |
|----|----------------|---------------|
| A. | 0.40%          | 5.40%         |
| B. | -0.40%         | 4.60%         |
| C. | 0.80%          | 5.80%         |
| D. | -0.80%         | 4.20%         |

**Answer: B**

Model 1 has a no-drift assumption. Using this model, the change in the interest rate is predicted as:

$$dr = \sigma d\omega$$

$$dr = 0.8\% \times (-0.5) = -0.4\% = -40 \text{ basis points}$$

Since the initial rate was 5% and  $dr = -0.40\%$ , the new spot rate in one month is:

$$5\% - 0.40\% = 4.60\%$$

57. An analyst is modeling spot rate changes using short rate term structure models. The current short-term interest rate is 5% with a volatility of 80 bps. After one month passes the realization of  $d\omega$ , a normally distributed random variable with mean 0 and standard deviation  $\sqrt{dt}$ , is -0.5. Assume a constant interest rate drift,  $\lambda$ , of 0.36%. What should the analyst compute as the new spot rate?

- A. 5.37%
- B. 4.63%
- C. 5.76%
- D. 4.24%

**Answer: B**

This short rate process has an annualized drift of 0.36%, so it requires the use of Model 2 (with constant drift). The change in the spot rate is computed as:

$$dr = \lambda dt + \sigma d\omega$$

$$dr = (0.36\% / 12) + (0.8\% \times -0.5) = -0.37\% = -37\text{bps}$$

Since the initial short-term rate was 5% and  $dr$  is -0.37%, the new spot rate in one month is:

$$5\% - 0.37\% = 4.63\%$$

58. Which of the following choices correctly characterizes basis-point volatility and yield volatility as a function of time within the lognormal model?

- | Basis-point volatility | Yield volatility |
|------------------------|------------------|
| A. Increases           | Constant         |
| B. Increases           | Decreases        |
| C. Decreases           | Constant         |
| D. Decreases           | Decreases        |

**Answer: A**

Choices B and D can be eliminated because yield volatility is constant. Basis-point volatility under the CIR model increases at a decreasing rate, whereas basis-point volatility under the lognormal model increases linearly. Therefore, basis-point volatility is an increasing function for both models.

59. Which of the following statements is most likely a disadvantage of the CIR model?

- A. Interest rates are always non-negative.
- B. Option prices from the CIR distribution may differ significantly from lognormal or normal distributions.
- C. Basis-point volatility increases during periods of high inflation.
- D. Long-run interest rates hover around a mean-reverting level.

**Answer: B**

Choices A and C are advantages of the CIR model. Out-of-the-money option prices may differ with the use of normal or lognormal distributions.

## Part 3.2: Basel Accord

### Key Point: Basel II-Three Pillars

**Pillar 1: Minimum capital requirements.** Banks should maintain a minimum level of capital to cover credit, market, and operational risks.

**Pillar 2: Supervisory review process.** Banks should assess the adequacy of capital relative to risk, and supervisors should review and take corrective action if problems occur.

**Pillar 3: Market discipline.** Risks should be adequately disclosed in order to allow market participants to assess a bank's risk profile and the adequacy of its capital.

### Key Point: Basel II-Forms of Capital

Tier 1: shareholder's equity, retained earnings; nonredeemable, noncumulative preferred stock.

Tier 2: undisclosed reserves, revaluation reserves, general provisions/general loan-loss reserves, hybrid debt capital instruments, and subordinated term debt.

Tier 3: short-term subordinated debt; can only be used to offset market risks.

### Key Point: Credit Risk Capital Requirements

The **standardized approach** incorporates risk weights based on external credit rating assessments. The amount of capital that a bank must hold is specific to the risk of credit-risky assets, the type of institution the claim is written on, and the maturity of those assets.

The **internal ratings-based (IRB)** approaches (foundation and advanced) use a bank's own internal estimates of creditworthiness to determine the risk weightings in the capital calculation.

- **Foundation approach:** bank estimates probability of default (PD).
- **Advanced approach:** bank estimates not only PD, but also loss given default (LGD), exposure at default (EAD), and effective maturity (M).

### Key Point: Market Risk Capital Requirements

**Standardized method:** determines capital charges associated with various market risk exposures (equity risk, interest rate risk, foreign exchange risk, commodity risk, and option risk). The market risk capital charge for each market risk is computed as 8% of its market-risky assets.

**Internal models approach (IMA):** allows a bank to use its own risk management systems to determine its market risk capital charge. The market risk charge is the higher of (1) the previous day's VaR or (2) the average VaR over the last 60 business days adjusted by a multiplicative factor (subject to a floor of 3).

$$MRC_t^{IMA} = \text{Max}\left(k \frac{1}{60} \sum_{i=1}^{60} VAR_{t-i}, VAR_{t-1}\right) \\ + \text{Max}\left(k_s \frac{1}{60} \sum_{i=1}^{60} SVAR_{t-i}, SVAR_{t-1}\right) + SRC_t + IRC_t$$

- *SVAR* is the Stress VAR.
- *SRC* is the specific risk charge, which is a buffer against idiosyncratic factors, including basis risk and event risk.
- *IRC* is an incremental risk charge, that covers (1) default risk and (2) credit migration risk for debt instruments. *IRC* is calibrated to a 99.9% confidence level over one year, computed on at least a

weekly basis. These parameters are selected to avoid arbitrage with the banking book. The IRC is computed from the maximum of the 12-week average and the most recent value:

$$IRC_t = \text{Max} \left( \frac{1}{12} \sum_{i=1}^{12} IRM_{t-i}, IRM_{t-1} \right)$$

**Key Point: Backtesting VaR**

An exception occurs if the day’s change in value exceeded the VaR estimate of the previous day. When backtesting VaR, the number of exceptions is determined for a 250-day testing period. Based on the number of exceptions, the bank’s exposure is categorized into one of three zones and VaR is scaled up by the appropriate multiplier.

- *Green zone:* 0-4 exceptions, increase in exposure multiplier is 0.
- *Yellow zone:* 5-9 exceptions, exposure multiplier increases between 0.4 and 0.85.
- *Red zone:* Greater than or equal to 10 exceptions, multiplier increases by 1.

**Key Point: Operational Risk Capital Requirements**

**Basic indicator approach:** measures the capital charge on a firm-wide basis. Banks will hold capital for operational risk equal to a fixed percentage of the bank’s average annual gross income over the prior three years. The Basel Committee has proposed a fixed percentage equal to 15%.

**Standardized approach:** allows banks to divide activities along standardized business lines. Within each business line, gross income will be multiplied by a fixed beta factor. The capital charge for operational risk is the sum of each business line’s charges. The beta factors for the eight business lines are as follows:

- Trading and sales: 18%
- Corporate finance: 18%
- Payment, settlement: 18%
- Commercial banking: 15%
- Agency services: 15%
- Retail banking: 12%
- Retail brokerage: 12%
- Asset management: 12%

**Advanced Measurement Approach (AMA):** If a bank can meet more rigorous supervisory standards, it may use the AMA for operational risk capital calculations. The capital charge for AMA is calculated as the bank’s operational value at risk (OpVaR) with a one-year horizon and a 99.9% confidence level. Having insurance can reduce this capital charge by as much as 20%.

Credit Risk	Market Risk	Operational Risk
Standardized Approach (modified version)	Standardized Approach	Basic Indicator Approach
Foundation Internal Rating Based Approach	Internal Models Approach	Standardized Approach
Advanced Internal Rating Based Approach		Advanced Measurement Approach



**Key Point: Stressed Value at Risk**

SVaR is calculated by combining current portfolio performance data with the firm's historical data from a significantly financial stressed period in the same portfolio. Calculation of SVaR is defined as follows:

$$\max(SVaR_{t-1}, \text{multiplicative factor} \times SVaR_{avg})$$

**Key Point: Basel III Changes****Basic Changes:**

- Raise capital standards (both quality and quantity).
- Improving the transparency and consistency of bank capital.
- Strengthen risk coverage of capital framework.
- Require leverage ratio to supplement risk-based capital requirements.
- Promote countercyclical buffers to offset the procyclical amplification of financial shocks.
- Institute policies to address systemic risk and interconnectedness of the financial sector.
- Institute global liquidity standard (liquidity, funding, and monitoring metrics).

**Capital Conservation Buffer:**

This will be required to provide an extra cushion against loss in times of stress. The buffer will be an additional 2.5% Common Equity Tier 1 capital requirement.

**Leverage Ratio:**

The committee has introduced a non-risk based leverage ratio that will act as a supplementary measure to risk-based capital standards. The goals of the leverage ratio are to constrain the build-up of leverage in the banking sector and to provide a simple “back-stop” measure of leverage that supplements and reinforces risk-based capital standards. The leverage ratio of 3% (Tier 1 capital to on- and off-balance sheet items and exposures) is targeted to take effect January 1, 2018.

**Countercyclical Buffer:**

Banks will be subject to a countercyclical buffer if regulatory authorities deem it necessary. The buffer is intended to protect the banking sector by ensuring that capital requirements take into account macro-environment factors. Procyclical amplification refers to the vicious cycle that ensues when a downturn leads to losses in the financial sector, which spreads to the real economy and then back to the financial sector. Countercyclical buffers are intended to dampen the effect of procyclical amplification and will only be implemented if credit growth is excessive or some other system-wide risk is evident.

**Key Point: Liquidity Coverage Ratio**

*Goal:* ensure banks have adequate, high-quality liquid assets to survive short-term stress scenario.

$$LCR = \frac{\text{stock of high-quality liquid assets}}{\text{total net cash outflows over the next 30 calendar days}} \geq 100\%$$

**Key Point: Net Stable Funding Ratio**

*Goal:* protect banks over a longer time horizon than LCR.

$$NSFR = \frac{\text{available amount of stable funding}}{\text{required amount of stable funding}} \geq 100\%$$

60. As a risk manager for Bank ABC is asked to calculate the market risk capital charge of the bank's trading portfolio under the internal models approach using the information given in the table below. Assuming the return of the banks trading portfolio is normally distributed, what is the market risk capital charge of the trading portfolio?

VaR (95%, 1-day) of last trading day	USD 30,000
Average VaR (95%, 1-day) for last 60 trading days	USD 20,000
Multiplication Factor	3

- A. USD 84,582  
 B. USD 134,594  
 C. USD 189,737  
 D. USD 267,471

**Answer: D**

Explanation: Market Risk Capital Charge

$$\text{MAX}(30,000 * \text{SQRT}(10)/1.65 * 2.326, 3 * 20,000 * \text{SQRT}(10)/1.65 * 2.326) = 267,471$$

Candidate is required to convert the VaR (95%, 1-day) to a 95% 10-day VaR.

61. Using approved approaches, Barlop Bank has calculated the following values:

Risk-weighted assets for credit risk, $RWA_c$ :	USD 47 million
Market risk capital requirement, $CR_m$	USD 3.2 million
Operational risk capital requirement, $Cr_o$ :	USD 2.8 million

Assuming Tier 3 capital is USD 0, in which scenario below does Barlop Bank meet the Basel II minimum capital requirement?

(all figures in USD million)

	Tier 1 Capital	Tier 2 Capital	Deductions
A.	6.8	3.2	0.4
B.	6.2	4.8	0.8
C.	6.2	8.4	2.8
D.	4.8	6.2	0.0

**Answer: B**

**Explanation:** The total risk-weighted assets are:

$$RWA_t = RWA_c + 12.5 \times (CR_m + CR_o) = 47 + 12.5 \times (3.2 + 2.8) = \text{USD } 122 \text{ million}$$

Eligible regulatory capital is:  $RC = \text{Tier 1} + \text{Tier 2} - \text{Deductions}$

In addition, Tier 2 capital must be less than or equal to Tier 1 capital.

Minimum capital requirement is:  $RC / RWA_t \geq 8\%$ . In this case,  $RC \geq 0.08 \times 122 = 9,76$

$RC = 6.8 + \min(3.2, 6.8) - 0.4 = 9.6$  (Fails to meet the minimum capital requirement)

$RC = 6.2 + \min(4.8, 6.2) - 0.8 = 10.2$  (Meets the minimum capital requirement)

$RC = 6.2 + \min(8.4, 6.2) - 2.8 = 9.6$  (Fails to meet the minimum capital requirement)

$RC = 4.8 + \min(6.2, 4.8) - 0.0 = 9.6$  (Fails to meet the minimum capital requirement)

62. Based on “Supervisory Guidance for Assessing Banks’ Financial Instrument Fair Value Practices” issued by the Basel Committee, which of the following factors should be considered in determining whether the sources of fair values are reliable and relevant?

- i. Frequency and availability of prices / quotes
  - ii. Maturity of the market
  - iii. Agreement of values with those generated by internal models
  - iv. Number of independent sources that produce the prices / quotes
- 
- A. i and ii only
  - B. iii and iv only
  - C. i, ii and iii only
  - D. i, ii, and iv only

**Answer: D**

**Explanation:** Agreement with internally generated values is not necessary or relevant. The other three factors should be considered in determining the reliability and relevancy of the sources of fair values.

63. Which of the following roles should not reside within an independent global risk management function?

- A. Establish risk management policies and procedures.
- B. Review and approve risk management methodologies and models, in particular those used for pricing and valuation.
- C. Execute trading strategies to hedge out global market risk.
- D. Communicate risk management results to executive management and the board of directors, as well as investors, rating agencies, stock analysts, and regulators.

**Answer: C**

There is a potential conflict of interest between risk management and trading, even for hedging purposes.

64. Banks are required to maintain 8 percent of their assets as "Tier 1 Capital". Which of the following count towards this capital requirement?

- I. Shareholders equity.
  - II. Sovereign debt held in the trading book.
  - III. Common stock of other banks.
  - IV. Subordinated debt issued by the bank in question (subject to certain qualifying rules).
- A. I, II, and IV
  - B. II and III
  - C. I and IV
  - D. I only

**Answer: D**

Only equity capital and disclosed rescues (primarily after tax retained earnings) qualify as Tier 1 capital.

65. What would be the market risk capital requirement for a bank with a one day VaR of \$100 and a specific risk surcharge of \$30, based on the current BIS minimum capital requirements?
- A. \$300
  - B. \$316
  - C. \$949
  - D. \$979

**Answer: D**

The BIS market risk charge can be computed by:

$$MRC_t^{IMA} = \max\left(k \frac{1}{60} \sum_{i=1}^{60} VAR_{t-1}, VATR_{t-1}\right) + SRC_t$$

In this case we have only a 1-day VaR,

which BIS allows to be extrapolated into a 10-day VaR using the square root of time rule (with the VaR calculated at the 99 percent confidence level). The value of the multiplier k is normally 3. With the information given, the formula is:

$$MRC_t^{IMA} = \max((3)(\$100)(\sqrt{10}), \$100) + \$300 = \$978.68.$$

66. According to the Basel II Accord. "At the discretion of their national authority, banks may also use a third tier of capital (Tier 3). Consisting of short-term subordinated debt for the sole purpose of meeting a proportion of the capital requirements" for which of the following?
- A. Market risk charges only
  - B. Credit risk charges only
  - C. Market risk and credit risk charges
  - D. All types of risk charges

**Answer: A**

Tier 3 capital can only be used to satisfy capital requirements resulting from market risk charges and cannot be applied to credit risk charges. Other choices are incorrect except choice A.

67. John Smith is a bank supervisor responsible for the oversight of Everbright Group, a large banking conglomerate. Everbright Group now determines its credit risk profile according to the foundation IRB approach and assesses operational risk according to the standardized approach as described in the Basel II Capital Accord. Which of the following are specific issues that should be addressed as Dart of Smith's supervisory review process of Everbright Group?
- I. Review the bank's internal control systems.
  - II. Check compliance with transparency requirements as described in Pillar 3 of Basel II Accord.
  - III. Make sure that the bank estimates for LGD and EAD for its corporate loans are in compliance with supervisory estimates.
  - IV. Evaluate the impact of interest rate risk by assessing the impact of a 200 basis Point interest rate shock to the bank's capital position.
- A. I and III only
  - B. II and IV only
  - C. I, II, and IV only
  - D. I, II, III, and IV

**Answer: C**

The supervisor's duties as Dart of the supervisory review process include:

Check compliance with Pillars I and III of Basel II Accord. which would include credit risk mitigation and transparency requirements. Review internal control systems. Access internal capital management methods employed by the bank. So I and II are correct. Note that the foundation IRB approach. the bank provides its estimates for PD but uses supervisory estimates for LGD and EAD for corporate loans. So III is incorrect. Also, the impact of interest rate risk on the bank's capital position must be accessed by determining the impact of a 200 basis Point shock or its equivalent. So IV is also correct. Therefore, the correct answer for this question is choice C.

68. Your bank is implementing the advanced Internal Rating Based Approach of Basel II for credit risk, and the Advanced Measurement Approach for operational risk. The bank uses the model approach for market risk. The Chief Risk Officer (CRO) wants to estimate the bank's total risk by adding up the regulatory capital for market risk, credit risk, and operational risk. The CRO asks you to identify the problems with using this approach to estimate the bank's total risk. Which of the following statements about this approach is incorrect?
- A. It assumes market, credit, and operational risks have zero correlation.

- B. It uses a 10-day horizon for market risk.
- C. It ignores strategic risks.
- D. It ignores the interest risk associated with the bank's loans.

**Answer: A**

It is the perfect correlation.

69. As a risk manager for Bank ABC, John is asked to calculate the market risk capital charge of the bank's trading portfolio under the 1996 internal models approach. The VAR (95%, one-day) of the last trading day is USD 30,000; the average VAR (95%, one-day) for the last 60 trading days is USD 20,000. The multiplier is  $k = 3$ . Assuming the return of the bank's trading portfolio is normally distributed, what is the market risk capital charge of the trading portfolio?
- A. USD 84,582
  - B. USD 189,737
  - C. USD 268,200
  - D. USD 134,594

**Answer: C**

70. Given the following information, what is Bank A's liquidity coverage ratio?
- |   |       |
|---|-------|
| • High-quality liquid assets                        | \$100 |
| • Required amount of stable funding                 | \$200 |
| • Cash outflows over the next 30 days               | \$130 |
| • Net cash outflows over the next 30 days           | \$90  |
| • Available amount of stable funding                | \$210 |
| • High-quality liquid assets in each major currency | \$75  |
- A. 83%
  - B. 90%
  - C. 111%
  - D. 130%

**Answer: C**

71. Given the following information, what is Bank A's net stable funding ratio?
- |   |       |
|---|-------|
| • High-quality liquid assets              | \$100 |
| • Required amount of stable funding       | \$200 |
| • Cash outflows over the next 30 days     | \$130 |
| • Net cash outflows over the next 30 days | \$90  |
| • Available amount of stable funding      | \$210 |

- High-quality liquid assets in each major currency      \$75
  
- A. 65%
- B. 89%
- C. 105%
- D. 125%

**Answer: C**

The longer-term funding ratio is equal to the available amount of stable funding divided by the required amount of stable funding. Under Basel III, this ratio must exceed 100%. Bank A's net stable funding ratio =  $\$210 / \$200 = 105\%$

72. In the latest guidelines for computing capital for incremental risk in the trading book, the incremental risk charge (IRC) addresses a number of perceived shortcomings in the 99%/10-day VAR framework. Which of the following statements about the IRC are *correct*?
- I. For all IRC-covered positions, the IRC model must measure losses due to default and migration over a one-year horizon at a 99% confidence level.
  - II. A bank can incorporate into its IRC model any securitization positions that hedge underlying credit instruments held in the trading account.
  - III. A bank must calculate the IRC measure at least weekly, or more frequently as directed by its supervisor.
  - IV. The incremental risk capital charge is the maximum of (1) the average of the IRC measures over 12 weeks and (2) the most recent IRC measure.
- A. I and II
  - B. III and IV
  - C. I, II, and III
  - D. II, III, and IV

**Answer: B**

Confidence level is 99.9%. Securitizations are subject to the banking book capital requirements.

73. Within the framework of risk analysis, which of the following choices would be considered most critical when looking at risk within financial institutions?
- A. Computing separate capital requirements for a bank's trading and banking book.
  - B. Proper analysis of stressed VaR.
  - C. Persistent use of backtesting.
  - D. Consideration of interactions among risk factors.

**Answer: D**

A unified approach is not used within the Basel framework, so the interaction among various risk factors is not considered when computing capital requirements for market, credit and operational

risk; however, these interactions should be considered due to risk diversification.

**74.** The capital conservation buffer:

- A. Will provide an extra 2.5% Common Equity Tier 1 capital buffer in times of stress.
- B. Will be used exclusively to protect banks from the losses garnered from OTC derivatives trading.
- C. Is required only for banks with inadequate liquidity coverage and net stable funding source ratios.
- D. Is covered in the increased Common Equity Tier 1 capital to risk-weighted assets ratio that will increase to 4.5% from the current 2% over the next few years.

**Answer: A**

The capital conservation buffer is intended to provide an extra cushion against loss in times of stress. It is 2.5% Common Equity Tier 1 capital to risk-weighted assets, which in effect increases the total Common Equity Tier 1 capital ratio to 7%.

**75.** A measure intended to protect the banking sector by taking macro-environment factors into consideration is the:

- A. Leverage ratio.
- B. Procyclical deleveraging ratio.
- C. Countercyclical buffer.
- D. Counterparty credit risk adjustor.

**Answer: C**

The countercyclical buffer requires that banking authorities monitor credit growth and other system-wide factors. If system-wide risks increase, authorities can require banks to hold additional capital, called the countercyclical buffer.

**76.** Which of the following statements would be considered a drawback of Basel II/III?

- A. Procyclicality is a concern, and no countercyclical buffer is provided.
- B. It does not consider diversification effects among risk classes.
- C. Level 1 diversification benefits are not acknowledged.
- D. There are no detailed disclosure requirements for risk management policies concerning credit risk.

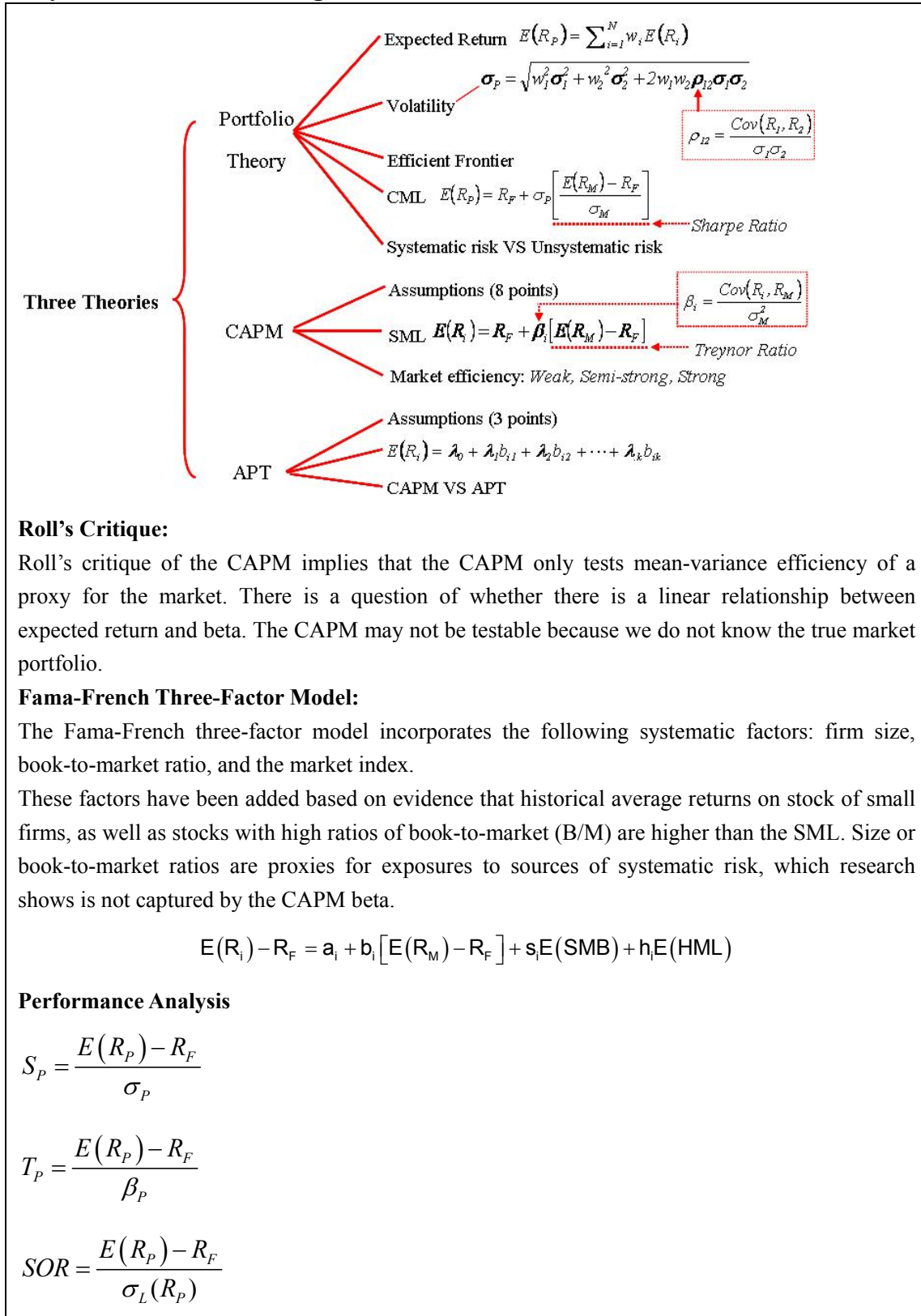
**Answer: B**

Basel II/III only considers Level 1 diversification benefits. It considers the sum of the risks but not the interrelationships among risk factors.



## Part 4: Risk Management and Investment Management

### Key Point: Portfolio Management



#### Roll's Critique:

Roll's critique of the CAPM implies that the CAPM only tests mean-variance efficiency of a proxy for the market. There is a question of whether there is a linear relationship between expected return and beta. The CAPM may not be testable because we do not know the true market portfolio.

#### Fama-French Three-Factor Model:

The Fama-French three-factor model incorporates the following systematic factors: firm size, book-to-market ratio, and the market index.

These factors have been added based on evidence that historical average returns on stock of small firms, as well as stocks with high ratios of book-to-market (B/M) are higher than the SML. Size or book-to-market ratios are proxies for exposures to sources of systematic risk, which research shows is not captured by the CAPM beta.

$$E(R_i) - R_F = a_i + b_i [E(R_M) - R_F] + s_i E(SMB) + h_i E(HML)$$

#### Performance Analysis

$$S_P = \frac{E(R_P) - R_F}{\sigma_P}$$

$$T_P = \frac{E(R_P) - R_F}{\beta_P}$$

$$SOR = \frac{E(R_P) - R_F}{\sigma_L(R_P)}$$

$$\alpha_p = E(R_p) - R_F - \beta_p (E(R_M) - R_F)$$

$$IR = \frac{E(R_p) - E(R_B)}{\sigma_{e_p}}$$

$$\sigma_{e_p}^2 = \sigma_{(P-B)}^2 = \sigma_P^2 + \sigma_B^2 - 2 \times \rho \times \sigma_P \times \sigma_B$$

The information ratio also allows us to estimate a suitable number of years for observing the

performance:  $IR \approx \frac{t_{stat}}{\sqrt{T}} \rightarrow T = \left[ \frac{t_{stat}}{IR} \right]^2$

77. How would results of early tests to the CAPM and the SML be described, in terms of the estimated SML?
- The estimated SML was too steep.
  - The estimated SML was too flat.
  - The estimated SML was curvilinear.
  - The intercept of the estimated SML was less than zero.

**Answer: B**

Early tests show results inconsistent with the CAPM. The estimated SML was too flat, and the intercept was greater than zero.

78. Roll's critique criticizes many of the central premises of the CAPM. Richard Roll's most critical argument is described in which of the following statements?
- The market proxy is not representative of the true market portfolio, and thus the CAPM is not testable.
  - Systematic risk does not explain average security returns.
  - There is an unresolved equity premium puzzle.
  - Consumption-based CAPMs improve traditional CAPM results.

**Answer: A**

Roll's critique implied that the CAPM is not testable unless the exact composition of the true market portfolio is known.

79. A manager who obtains an average alpha of 2.5% with a tracking-error of 4%. If he wish the result to be significant to 95%, how many years it is necessary to observe the portfolio return?
- 8.8 years
  - 9.8years
  - 10.8years
  - 11.8years

**Answer: B**

$$IR \approx \frac{t_{stat}}{\sqrt{T}} \rightarrow T = \left[ \frac{t_{stat}}{IR} \right]^2 = \left[ \frac{1.96}{2.5\% / 4\%} \right]^2 = 9.8 \text{ years}$$

**80.** You are evaluating the performance of Valance, an equity fund designed to mimic the performance of the Russell 2000 Index. Based upon the information provided below, what is the best estimate of the tracking error of Valance relative to the Russell 2000 Index?

- Annual volatility of Valance: 35%
- Annual volatility of the Russell 2000 Index: 40%
- Correlation between Valance and the Russell 2000 Index: 0.90

- A. 3.1%
- B. 17.5%
- C. 39.6%
- D. 53.2%

**Answer: B**

**Explanation:**

$$\begin{aligned} \omega^2 &= \sigma(p-B)^2 = \sigma(p)^2 + \sigma(B)^2 - 2 \times \sigma(p) \times \sigma(B) \times \rho \\ &= 0.35^2 + 0.4^2 - 2 \times 0.35 \times 0.4 \times 0.9 = 0.0305 \\ \omega &= 17.5\% \end{aligned}$$

**81.** Rick Masler is considering the performance of the managers of two funds, the HCM Fund and the GRT Fund. He uses a linear regression of each manager's excess returns ( $r_i$ ) against the excess returns of a peer group ( $r_B$ ):

$$r_i = a_i + b_i * r_B + e_i$$

The information he compiles is as follows:

Fund	Initial Equity	Borrowed Funds	Total Investment Pool	$a_i$	$b_i$
HCM	USD 100	USD 0	USD 100	0.0150 (t = 4.40)	0.9500 (t = 12.1)
GRT	USD 500	USD 3,000	USD 3,500	0.0025 (t = 0.002)	3.4500 (t = 10.20)

Based on this information, which of the following statements is correct?

- A. The regression suggests that both managers have greater skill than the peer group.
- B. The  $a_i$  term measures the extent to which the manager employs greater or lesser amounts of leverage than do his/her peers.
- C. If the GRT Fund were to lose 10% in the next period, the return on equity (ROE) would

be -60%.

- D. The sensitivity of the GRT fund to the benchmark return is much higher than that of the HCM fund.

**Answer: D**

Explanation: Statement d is correct as can be seen from the b coefficient. It is higher for GRT and lower for HCM. This indicates that the sensitivity of the GRT fund to the benchmark return is much higher than that of the HCM fund.

82. Consider two stocks, A and B. Assume their annual returns are jointly normally distributed, the marginal distribution of each stock has mean 2% and standard deviation 10%, and the correlation is 0.9. What is the expected annual return of stock A if the annual return of stock B is 3%?
- A. 2%  
B. 2.9%  
C. 4.7%  
D. 1.1%

**Answer: B**

83. A fund manager recently received a report on the performance of his portfolio over the last year. According to the report, the portfolio return is 9.3%, with a standard deviation of 13.5%, and beta of 0.83. The risk-free rate is 3.2%, the semi-standard deviation of portfolio is 8.4%, and the tracking error of the portfolio to the benchmark index is 2.8%. What is the difference between the value of the fund's sortino ratio (computed relative to the risk-free rate) and its Sharpe ratio?
- A. 1.727  
B. 0.274  
C. -0.378  
D. 0.653

**Answer: B**

Sharp ratio =  $(9.3\% - 3.2\%) / 13.5\% = 0.4519$ , Sortino ratio =  $(9.3\% - 3.2\%) / 8.4\% = 0.7262$ , so Sortino ratio - sharp ratio = 0.274

84. A portfolio has an average return over the last year of 13.2%. Its benchmark has provided an average return over the same period of 12.3%. The portfolio's standard deviation is 15.3%, its beta is 1.15, its tracking error volatility is 6.5% and its semi-standard deviation is 9.4%. Lastly, the risk-free rate is 4.5%. Calculate the portfolio's information Ratio (IR).

- A. 0.569
- B. 0.076
- C. 0.138
- D. 0.096

**Answer: C**

**85.** Market portfolio's sharp ratio is 40%, the correlation between the market portfolio and the stock is 0.7, the stock's sharp ratio is

- A. 12%
- B. 28%
- C. 32%
- D. 30%

**Answer: B**

$$E(R_i) - R_f = \beta_i \times [E(R_M) - R_f]$$

$$\frac{E(R_i) - R_f}{\sigma_i} = \frac{\beta_i \times [E(R_M) - R_f]}{\sigma_i} = \frac{\beta_i}{\sigma_i} \sigma_M \times \frac{[E(R_M) - R_f]}{\sigma_M} = \rho_i \times \frac{[E(R_M) - R_f]}{\sigma_M} = 0.7 \times 40\% = 28\%$$

**86.** Portfolio Q has a beta of 0.7 and an expected return of 12.8%. The market risk premium is 5.25%. The risk-free rate is 4.85%. Calculate Jensen's Alpha measure for Portfolio Q.

- A. 7.67%
- B. 2.70%
- C. 5.73%
- D. 4.27%

**Answer: D**

Explanation: Jensen's alpha is defined by:

$$\alpha_p = E(R_p) - R_f - \beta_p (E(R_M) - R_f) = 0.128 - 0.0485 - 0.7 \times 0.0525 = 4.27\%$$

**87.** Based on 60 monthly returns, you estimate an actively managed portfolio alpha=1.24% and standard error of alpha=0.1278%. The portfolio manager wants to get due credit for producing positive alpha and believes that the probability of observing such a large alpha by chance is only 1%. Calculate the t-statistic, and based on the estimated t-value would you accept (or reject) the claim made by the portfolio manager.

- A. t=9.70, accept

- B.  $t=2.66$ , accept
- C.  $t=2.66$ , reject
- D.  $t=9.70$ , reject

**Answer: A**

$$t = \frac{\alpha}{S.E.(\alpha)}$$

$$t = \frac{1.24\%}{0.1278\%} = 9.702$$

With 60 observations and such a large  $t$  value, you would have rejected  $H_0$  ( $\alpha=0$ ). The manager should receive credit for the statistically significant  $\alpha$ .

### Key Point: Liquidity Duration

It is an approximation of the number of days necessary to dispose of a portfolio's holdings without a significant market impact.

$$LD = \frac{\text{number of shares of a security}}{[\text{desired max daily volume}(\%) \times \text{daily volume}]}$$

- 88.** A portfolio manager currently holds 20,000 shares of Costiuk Inc. in a particular portfolio. The daily volume of Costiuk shares traded on the stock exchange is 50,000. Additionally, on any given day, the portfolio manager wishes to trade no more than 15% of the daily trading volume of Costiuk. Which of the following amounts is closest to the liquidity duration of Costiuk in this portfolio?

- A. 0.06
- B. 0.375
- C. 2.67
- D. 16.67

**Answer: C**

Liquidity duration is an approximation of the number of days necessary to dispose of a portfolio's holdings (of a particular share in this case) without a significant market impact. It is calculated as:  $20,000 / (0.15 \times 50,000) = 2.67$ . (See Book 4, Topic 51)

### Key Point: Portfolio VaR, Marginal VAR (边际 VAR), Incremental VAR (增量 VAR), Component VAR (成分 VAR)

#### For a two-asset portfolio

- ✓ VAR for uncorrelated positions ( $\rho=0$ ):  $VARP = (\text{VAR}_1^2 + \text{VAR}_2^2)^{1/2}$
- ✓ Undiversified VAR ( $\rho=1$ ):  $VARP = \text{VAR}_1 + \text{VAR}_2$

$$\text{Marginal VAR} = \text{MVAR}_i = \frac{\text{VAR}}{P} \times \beta_i$$

$$\text{Incremental VAR} \approx \text{MVAR}_i \times P_i = \text{MVAR}_i \times w_i \times P$$

$$\text{Component VAR}_i \approx \text{MVAR}_i \times w_i \times P = \text{VAR} \times w_i \times \beta_i$$

$$\text{Global Minimum Portfolio: } \text{MVAR}_i = \text{MVAR}_j$$

$$\text{Optimal Portfolio: } \frac{\text{Position i return} - \text{risk free rate}}{\text{MVAR}_i} = \frac{\text{Position j return} - \text{risk free rate}}{\text{MVAR}_j}$$

The next two questions are based on the following information.

A risk manager assumes that the joint distribution of returns is multivariate normal and calculates the following risk measures for a 2-asset portfolio:

Asset	Position	Individual VaR	Marginal VaR	VaR Contribution
1	USD 100	USD 23.3	0.176	USD 17.6
2	USD 100	USD 46.6	0.440	USD 44.0
Portfolio	USD 200	USD 61.6		USD 61.6

89. If asset 1 is dropped from the portfolio, what will be the reduction in portfolio VaR?

- A. USD 15.0
- B. USD 38.3
- C. USD 44.0
- D. USD 46.6

**Answer: A**

Explanation: A is correct: The new portfolio VaR is that of asset 2 alone (USD 46.6), which implies a reduction in portfolio VaR of USD 61.6 - USD 46.6 = USD 15.0,

90. Let  $\beta_i = \rho_{ip} \frac{\sigma_i}{\sigma_p}$ , where  $\rho_{ip}$  denotes the correlation between the return of asset  $i$  and the return of the portfolio,  $\sigma_i$  is the volatility of the return of asset  $i$  and  $\sigma_p$  is the volatility of the return of the portfolio. What is  $\beta_2$ ?

- A. 0.714
- B. 1.429
- C. 1.513
- D. Cannot determine from information provided.

**Answer: B**

Explanation: Marginal VaR<sub>i</sub> =  $\beta_i$  \* Portfolio VaR / Portfolio Value

So,  $\beta_i = \text{Marginal VaR}_i * \text{Portfolio Value} / \text{Portfolio VaR}$

$$\beta_2 = 0.44 * 200 / 61.6 = 1.429$$

91. Consider a USD 1 million portfolio with an equal investment in two funds, Alpha and Omega, with the following annual return distributions:

错误! 未找到引用源。

Assuming the returns follow the normal distribution and that there are 252 trading days per year, what is the maximum possible daily 95% Value-at-Risk (VaR) estimate for the portfolio?

- A. USD 16,587
- B. USD 23,316
- C. USD 23,459
- D. USD 32,973

**Answer: B**

**Explanation:** This question tests that the candidate understands correlation in calculating portfolio VaR. From the table, we can get daily volatility for each fund:

Fund Alpha volatility:  $0.20 / 252^{0.5} = 1.260\%$

Fund Omega volatility:  $0.25 / 252^{0.5} = 1.575\%$

Portfolio variance:

$$0.5^2 * 0.01259^2 + 0.5^2 * 0.01574^2 + 2 * 0.5 * 0.5 * 0.01259 * 0.01574 * \rho$$

Portfolio volatility = (portfolio variance)<sup>0.5</sup>

Portfolio volatility is least when  $\rho = -1 \rightarrow$  portfolio volatility = 0.1575%

Portfolio volatility is greatest when  $\rho = 1 \rightarrow$  portfolio volatility = 1.4175%

Therefore, 95% VaR maximum is  $1.645 * 0.014175 * 1,000,000 = \text{USD}23,316$

92. A portfolio consists of two positions. The VAR of the two positions are \$10 million and \$20million. If the returns of the two positions are not correlated. The VAR of the portfolio would be closest to:

- A. \$5.48million
- B. \$15.00million
- C. \$22.36million
- D. \$25.00million

**Answer: C**

For uncorrelated positions, the answer is the square root of the sum of the spread VARs:

$$VAR_p = \sqrt{(10^2 + 20^2)} \times (\$million) = \$22.36million$$

93. Given the following information, what is the percent of contribution to VAR from Asset A? There are two assets in a portfolio: A and B.



Asset A marginal VAR:	0.05687
Asset A value:	\$7,000,000
Asset B marginal VAR:	0.17741
Asset B value:	\$4,000,000

- A. 64.06%
- B. 24.27%
- C. 35.94%
- D. 63.64%

**Answer: C**

The component VAR factors in both the marginal VAR and the asset value.

For Asset A:  $0.05687 \times \$7,000,000 = \$398,090$

For Asset B:  $0.17741 \times \$4,000,000 = \$709,640$

Asset A's percent of contribution to VAR is A's component VAR as a percent of total VAR:  
 $\$398,090 / (\$398,090 + \$709,640) = 35.94\%$

Choice A is incorrect because it is the percent of contribution to VAR from Asset B.

Choice B is incorrect because it is the Marginal VAR weight for Asset A.

Choice D is incorrect because it is just the asset weight for Asset A.

94. A portfolio is composed of two securities and has the following characteristics:

Investment in X:	USD 1.8 million
Investment in Y:	USD 3.2 million
Volatility of X:	8%
Volatility of Y:	4%
Correlation between X and Y:	15%

The portfolio diversified VAR at the 95% confidence level is closest to:

- A. \$14,074
- B. \$206,500
- C. \$404,740
- D. \$340,725

**Answer: D**

Step1: Calculate the volatility of the portfolio.

$$\text{Variance}_{X,Y} = w_X^2 \sigma_X^2 + w_Y^2 \sigma_Y^2 + 2 \times w_X \times w_Y \times \sigma_X \times \sigma_Y \times \text{Corr}_{X,Y}$$

$$\text{Variance}_{X,Y} = 0.36^2 \times 0.08^2 + 0.64^2 \times 0.04^2 + 2 \times 0.36 \times 0.64 \times 0.08 \times 0.04 \times 0.15$$

$$\text{Variance}_{X,Y} = 0.00082944 + 0.00065536 + 0.000221184$$

$$\text{Variance}_{X,Y} = 0.001705984$$

Standard deviation =  $\sqrt{0.001705984} = 4.13\%$

Step 2: Calculate the VAR

VAR =  $1.65 \times \text{volatility} \times \text{portfolio value}$

VAR =  $1.65 \times 0.0413 \times \$ 5\text{m}$

VAR = \$340,725

### Key Point: Risk Budgeting

#### Budget Risk across Asset Classes

- Budgeting risk across asset classes means selecting assets whose combined VaRs are less than the total allowed. The budgeting process would examine the contribution each position makes to the portfolio VaR.

#### Budget Risk across Active Managers

- For allocating across active managers, if the tracking errors of the managers are independent of each other, it can be shown that the optimal allocation is achieved with the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{IR_i \times (\text{portfolio's Vol tracking error})}{IR_p \times (\text{manager's Vol tracking error})}$$

- For a given group of active managers, the weights may not sum to one. The remainder of the weight can be allocated to the benchmark, which has no tracking error.

95. The manager of the BetaBalance fund, a balanced global equity and fixed-income portfolio, believes that globalization is causing the correlations of equity and fixed-income returns across different markets to rise over time. He decides to adjust the correlations in his VAR analysis for the coming year to reflect the higher correlations he expects. If his expectation turns out to be incorrect, what is the *most likely* result?
- There will be no impact on the portfolio because VAR is only a prediction, and portfolio return depends on what actually happens.
  - The portfolio return will be lower than it should have been, given the expected risk level, because asset allocation will not have been optimal.
  - The risk of the portfolio will have been understated because of the incorrect estimate of correlation among global markets.
  - The portfolio return will be higher than it should have been, given the expected risk level, because of the higher correlation among asset classes

Answer: B

An error in predicting correlation among asset classes will cause the calculation of optimal asset allocation to be in error as well. Thus, the asset allocation of the portfolio will be less than optimal. Any portfolio that does not have optimal asset allocation will, by definition, have returns that are too low for the expected level of risk. The risk of the portfolio will be overstated because the estimates of correlation among markets were too high.

96. The AT&T pension fund has 68%, or about \$13 billion invested in equities. Assume a normal distribution and volatility of 15% per annum. The fund measures absolute risk with a 95%, one-year VAR, which gives \$3.2 billion. The pension plan wants to allocate this risk to two equity managers, each with the same VAR budget. Given that the correlation between managers is 0.5, the VAR budget for each should be
- A. \$3.2 billion
  - B. \$2.4 billion
  - C. \$1.9 billion
  - D. \$1.6 billion

**Answer: C**

Call  $x$  the risk budget allocation to each manager. This should be such that:

$$x^2 + x^2 + 2\rho xx = \$3.2^2.$$

Solving for:

$$x\sqrt{1+1+2\rho} = x\sqrt{3} = \$3.2, \text{ we find } x = \$1.85\text{billion}.$$

Answer A) is incorrect because it refers to the total VaR. Answer B) is incorrect because it assumes a correlation of zero. Answer D) is incorrect because it simply divides the \$3.2 billion VaR by 2, which ignores diversification effects.

97. The buy side and sell side of the investment industry have different characteristics when it comes to turnover, investment horizon, leverage, and risk measures used. Which of the following characterizes the side of investment industry that would be inclined to use VAR as one of their primary risk measures?
- I. Long-term investment horizon
  - II. High leverage
  - III. Fast turnover
  - IV. Stop-loss rules are an important form of risk control
- A. I, II and III
  - B. II and III
  - C. II, III and IV
  - D. I, II, III and IV

**Answer: C**

The sell side of the investment industry uses VAR and stress tests as their primary risk measures. The buy side of the investment industry uses asset allocation and tracking error. The sell side has a short-term investment horizon, uses high leverage, and has fast turnover. Risk controls used are

position limits, VAR limits, and stop-loss limits. Therefore, all statements are correct except for Statement I.

98. Given the information provided in the table below, what is the risk budget, at the 99% confidence level of the following CHF million equally weighted investment portfolios?

Asset	Expected Return	Volatility	Correlation	
			Stocks	Bonds
Stocks	24.00%	18%	1	0.1
Bonds	15.00%	6%	0.1	1

- A. CHF 20.97 million
- B. CHF 13.98 million
- C. CHF 27.96 million
- D. CHF 22.77 million

**Answer: D**

$$100M \times 1/2 \times \sqrt{0.18^2 + 0.06^2 + 2 \times 0.18 \times 0.06 \times 0.1} = 22.77M$$

99. SkyLine Airways has a defined benefit pension scheme with assets of \$165 million and liability of \$150 million. The annual growth of the liabilities is expected to be 4.5% with 2.4% volatility. The annual return on the pension assets has an expected value of 7.8% with 12% volatility. The correlation between asset return and liability growth is 0.35. What is the 95% surplus at risk for SkyLine?

- A. \$24.97million
- B. \$54.81million
- C. \$18.84million
- D. \$6.12million

**Answer: A**

Step 1: Calculate the expected surplus growth.

Expected surplus growth=growth in assets-growth in liabilities

Expected surplus growth=(\$ 165m × 0.078)-(\$ 150m × 0.045)

Expected surplus growth=\$12.87m-\$6.75m=\$6.12m

Step 2: Calculate the variance then the standard deviation of the A&L

$$\text{Var}_{A\&L} = w_A^2 \sigma_A^2 + w_L^2 \sigma_L^2 - 2 \times w_A \times w_L \times \sigma_A \times \sigma_L \times \text{Corr}_{AL}$$

$$\text{Var}_{A\&L} = 165^2 \times 0.12^2 + 150^2 \times 0.024^2 - 2 \times 165 \times 150 \times 0.12 \times 0.024 \times 0.35$$

$$\text{Var}_{A\&L} = 392.04 + 12.96 - 49.896$$

$$\text{Var}_{A\&L} = 355.104$$

$$\text{Standard deviation} = \sqrt{355.104} = 18.84m$$

Step 3: Calculate VAR of the assets.

$$\text{VAR} = Z\text{-score} \times \text{volatility}$$

$$\text{VAR} = 1.65 \times \$18.84m$$

$$\text{VAR} = \$31,086,000$$

Surplus at risk = expected growth in surplus - VAR

$$\text{Surplus at risk} = \$6.12m - \$31.086m = -\$24.97m$$

Note: Although it is a negative, it is usually expressed as a positive figure as it is assumed that it is a shortfall.

### Key Point: Hedge Fund Trading Strategy

**Equity long/short strategy:** go long and short similar securities to exploit mispricings-decreases market risk and generates alpha.

**Global macro strategy:** makes leveraged bets on anticipated price movements in broad equity and fixed-income markets, interest rates, foreign exchange, and commodities.

**Emerging markets strategy:** invests in developing countries' securities or sovereign debt.

**Fixed-income arbitrage strategy:** long/short strategy that looks for pricing inefficiencies between various fixed-income securities.

**Convertible arbitrage strategy:** investor purchases a convertible bond and sells short the underlying stock.

**Merger arbitrage strategy:** involves purchasing shares in a target firm and selling short shares in the purchasing firm.

**Distressed investing strategy:** purchase bonds of distressed company and sell short the stock, anticipating that the shares will eventually be worthless.

**Fund of hedge funds:** perform screening and due diligence of other funds. Fees can be extensive, and the due diligence does not always identify fraud. A key advantage is diversification benefit without large capital commitment.

100. Which of the following statements about convertible arbitrage hedge fund strategies is correct?

- A. Credit risk plays only a minor role in convertible arbitrage hedge funds.
- B. Investing in convertible arbitrage does not require an understanding of liquidity considerations as the market for convertible securities is sufficiently liquid today.
- C. Gamma trading entails significant directional exposure to the equity markets.
- D. Re-hedging after a large gain yields trading gains for a typical hedged position in convertible arbitrage hedge funds.

**Answer: D**

**Explanation:** Re-hedging after significant moves of the underlying stock price is the essence of gamma trading. Credit risk plays an important role in the risk profile of convertible arbitrage

hedge funds. Liquidity considerations are essential. Ignorance of this risk can lead to devastating losses as the 2008 financial crisis showed. Gamma trading means frequent re-hedging of directional exposure after market moves.

**101.** Which of the following positions are commonly used by managers pursuing a volatility arbitrage strategy?

- I. Long position in fixed-income options with cheap volatility.
  - II. Short position in fixed-income options with expensive volatility.
  - III. Long position in fixed-income options with expensive volatility.
  - IV. Short position in fixed-income options with cheap volatility.
- 
- A. I and II
  - B. III and IV
  - C. II and III
  - D. I and IV

Answer: A

The volatility arbitrage manager generally takes a long position in cheap volatility and a short position in expensive volatility.

**102.** Identify the risks in a convertible arbitrage strategy that takes long positions in convertible bonds hedged with short positions in Treasuries and the underlying stock.

- A. Short implied volatility
- B. Long duration
- C. Long stock delta
- D. Positive gamma

**Answer: D**

This position is hedged against interest rate risk, so B) is wrong. It is also hedged against directional movements in the stock, so C) is wrong. The position is long an option (the option to convert the bond into the stock) and so is long implied volatility, so A) is wrong. Long options positions have positive gamma.

**103.** George Smith, a hedge fund manager, has just established a short position in short-term Swiss government bonds that are currently yielding 3.5% and a long position in short-term Italian government bonds that are yielding 4.2%. Smith believes the market has underestimated the probability that the Swiss Franc will appreciate relative to the euro. Which of the following hedge fund strategies is most similar to Smith's strategy?

- A. Pair trading strategy.
- B. Managed futures strategy.
- C. Global macro strategy.
- D. Event-driven strategy.

Answer: C

Global macro strategies take long and short positions based on expectations regarding fundamental changes in global capital markets. The manager in this scenario is engaging in a carry trade by taking a long position in a high-yielding currency (euros) and a short position in a low-yielding currency (Swiss Francs). The manager also expects a fundamental change in the exchange rate between the currencies. Managed futures strategies have a similar philosophy but use futures rather than the underlying assets to execute the strategy.

### Key Point: Hedge Fund Leverage

**104.** A hedge fund is long USD 315 million in certain stocks and short USD 225 million in other stocks. The hedge fund's equity is USD 185 million. The fund's overall beta is 0.75. Calculate the Gross and Net leverage.

- A. 2.91 and 0.48
- B. 2.18 and 0.36
- C. 2.91 and 0.36
- D. 2.18 and 0.48

Answer: A

$$\text{Gross leverage} = \frac{315 + 225}{185} = 2.91, \text{ Net leverage} = \frac{315 - 225}{185} = 0.48$$

### Key Point: Hedge Fund Investment Objective

**105.** An investment manager is given the task of beating a benchmark. Hence the risk should be measured

- A. In terms of loss relative to the initial investment
- B. In terms of loss relative to the expected portfolio value
- C. In terms of loss relative to the benchmark
- D. In terms of loss attributed to the benchmark

Answer: C

This is an example of risk measured in terms of deviations of the active portfolio relative to the benchmark. Answers a) and b) are incorrect because they refer to absolute risk. Answer d) is incorrect because it refers to the absolute risk of the benchmark.

**Key Point: Hedge Fund Risk**

**106.** Every year Business Week reports the performance of a group of existing equity mutual funds, selected for their popularity. Taking the average performance of this group of funds will create

- A. Survivorship bias only
- B. Selection bias only
- C. Both survivorship and selection bias
- D. Instant-history bias only

**Answer: C**

The publication lists existing funds, so it must be subject to survivorship bias, because dead funds are not considered. In addition, there is selection bias because the publication focuses on just the popular funds, which are large and likely to have done well. Answers a) and b) are incomplete. Answer d) is also incomplete.

**107.** Which of the following statements are true?

- I. Hedge fund manager compensation is often symmetric (i.e., a dollar of gain has the opposite impact on compensation as a dollar of loss), while the compensation of mutual fund managers is almost always asymmetric.
  - II. Leverage obtained through lines of credit increases the risk of a hedge fund more than leverage obtained by issuing debt, because unexpected cancellation of a line of credit by a lender during troubled times can force a fund to liquidate its positions in illiquid markets.
  - III. A hedge fund investor should pay performance-based compensation to the manager for producing alpha, but should not pay performance-based compensation to a hedge fund manager who has done well because the fund invests in risk factors that mirror the performance of his style or strategy, and the style or strategy has performed well.
  - IV. The lack of hedge fund transparency is particularly problematic for investors with fiduciary responsibilities such as pension fund managers, and to secure funding from these investors, hedge fund managers often have to provide more information to these investors.
- A. I, II, and IV only.
  - B. II, III, and IV only.
  - C. II and IV only.
  - D. I and III only.

**Answer: B**

Statements II, III, and IV are true. Statement I is false — the opposite is true.



### Key Point: Hedge Fund Style Drift

108. The Peyton Formika Fund is a global macro asset allocation hedge fund designed to provide low correlations with U.S. assets. Dominic James is a fund of hedge funds manager that is analyzing the Peyton Formika Fund for signs of style drift. James makes note of the following findings about the fund:

- I. The  $R^2$  of the fund versus the global macro peer group has changed from 0.72 to 0.78 over the past 12 months.
- II. Due to outstanding returns, assets in the fund have increased from \$70 million to \$430 million over the past 12 months.
- III. The fund made a major shift in allocation by moving 40 percent of its holdings from Eastern European equities to Asian equities.
- IV. After a recent trip to India, the fund manager gained confidence in his existing Indian equity holdings and levered his existing 5% weighting in India only by a 10 to 1 ratio.

Which of James' findings are indicators that the Peyton Formika Fund is at risk for style drift?

- A. II and IV only
- B. I and II only
- C. II and III only
- D. I, III and IV only

#### Answer: A

Hedge fund style drift occurs when there are changes in the risk factor exposures of the fund or changes in the overall risk of the fund, notably through leverage. Using leverage only for his Indian equity position would definitely be an indicator of style drift. Even though the initial position is small, a 10 to 1 leverage ratio would significantly change the risk of the fund. An excessive cash inflow which may be more money than the manager can sustain is also a potential indicator of style drift. The change in allocation from Eastern European equities to Asian equities is within the objectives of a global allocation fund, so that would not indicate style drift. Also, style drift would be a concern with a decrease, not an increase in the R-squared measure against the peer group.

### Key Point: Types of Private Equity Investments

**Leveraged Buyout (LBO):** investment group purchases a firm or a business unit using a large amount of debt.

**Growth Capital:** minority equity investments in established firms that need additional capital.

**Mezzanine Capital:** investment in subordinated debt or preferred stock in a firm.

**Venture Capital:** investments in start-ups or less mature non-public companies.

109. In a private equity transaction, what is the term for an investment in preferred stock or

subordinated debt?

- A. Growth capital.
- B. Bridge financing.
- C. Senior term debt.
- D. Mezzanine capital.

**Answer: D**

Mezzanine capital is an investment in preferred stock or subordinated debt without having voting control. These securities often have warrants attached.