



2017 FRM Part II

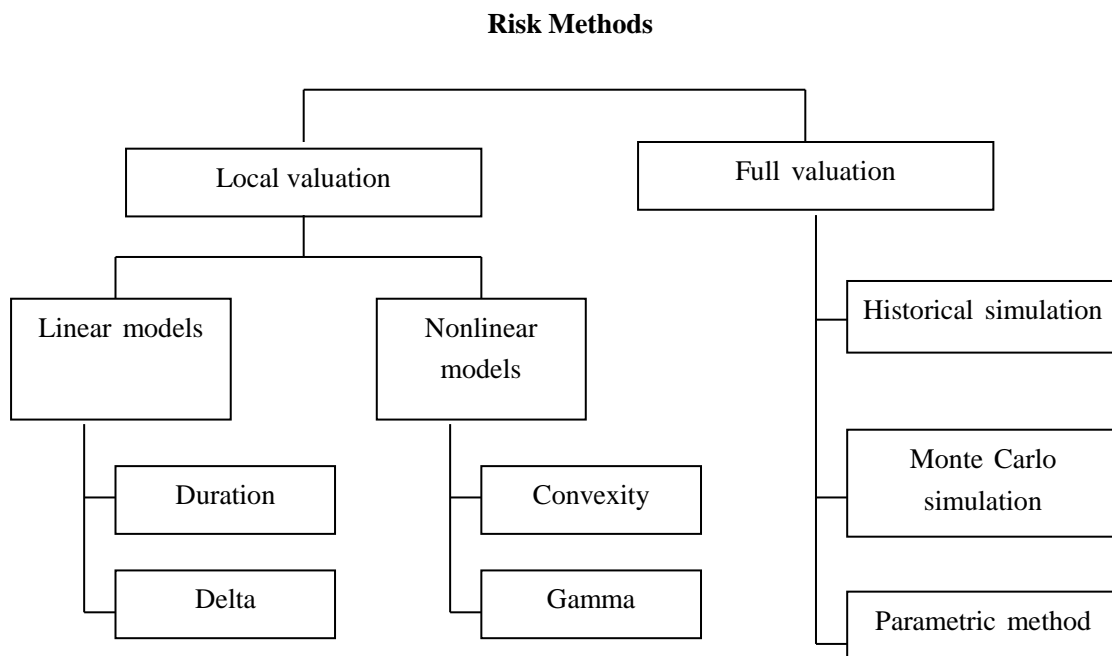
百题巅峰班

市场风险测量与管理

2017 年 5 月

Market Risk Measurement and Management

Key Point: Estimating VaR



Normal VaR:

$$\text{VaR}(\alpha\%) = (-\mu + \sigma \times Z_{\alpha}) \times P_{t-1}$$

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

$$\text{VaR}_p^2 = \text{VaR}_1^2 + \text{VaR}_2^2 + 2\rho \times \text{VaR}_1 \times \text{VaR}_2$$

$$\text{VaR}(dP) = -D^* P \times \text{VaR}(dy)$$

$$\text{VaR}(df) = \Delta \times \text{VaR}(dS)$$

$$\text{VaR}(dP) = -D^* P \times \text{VaR}(dy) + (1/2)(C^* P) \times \text{VaR}(dy)^2$$

$$\text{VaR}(df) = \Delta \times \text{VaR}(dS) + (1/2)\Gamma \times \text{VaR}(dS)^2$$

Lognormal VaR:

$$\text{VaR}(\alpha\%) = P_{t-1} \times (1 - e^{\mu - \sigma \times Z_{\alpha}})$$

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?

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Add / 上海市松花江路2539号复旦科技园1号楼/2号楼 (200437)

Tel / 400-700-9596

Web / WWW.GFEDU.NET

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- 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 risk analyst is comparing the use of parametric and non-parametric approaches for calculating VaR and is concerned about some of the characteristics present in the loss data. Which of the following distribution characteristics would make parametric approaches the favored method to use?
- A. Skewness in the distribution
 - B. Fat tails in the distribution
 - C. Scarcity of high magnitude loss events
 - D. Heteroskedasticity in the distribution

Answer: C

Non-parametric approaches can accommodate fat tails, skewness, and any other non-normal features that can cause problems for parametric approaches. However, if the data period that is used in estimation includes few losses or losses with low magnitude, non-parametric methods will often produce risk measures that are too low. Hence parametric methods would be more appropriate in those situations.

3. 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

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:

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

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4. 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

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

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

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

5. 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?

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

Answer: C

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

6. 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

The trade will decrease the VaR by 0.4581

7. 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

$$\text{VaR}(\text{df}) = \Delta \times \text{VaR}(\text{dS}) + (1/2) \Gamma \times \text{VaR}(\text{dS})^2$$

$$\text{VaR}(\text{df}) = 100,000 \times (-2.00) + (1/2) (-50,000) \times (-2.00)^2 = -\$300,000$$

8. 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)?

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- 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.

9. What is a key weakness of the value at risk (VaR) measure? VaR:
- A. Does not consider the severity of losses in the tail of the returns distribution.
 - B. Is quite difficult to compute.
 - C. Is subadditive.
 - D. has an insufficient amount of backtesting data

Answer: A

VaR does not consider losses beyond the VaR threshold level.

10. A mutual fund has USD 50 billion in assets. The risk manager computes the daily VaR at various confidence levels as follows:

Confidence Level	VaR (USD)
95.5%	787,000,000
96.0%	800,000,000
96.5%	835,000,000
97.0%	865,000,000
97.5%	895,000,000
98.0%	931,000,000
98.5%	979,000,000
99.0%	1,042,000,000
99.5%	1,139,000,000

What is the closest estimate of the daily expected shortfall at the 97.5% confidence level?

- A. USD 821 million
- B. USD 895 million
- C. USD 919 million
- D. USD 1023 million

Answer: D

An estimate of the expected shortfall can be obtained by taking the average of the VaRs for the various confidence levels that are greater than 97.5%. This leads to an estimate of USD 1,023,000,000.

11. A large commercial bank is using VaR as its main risk measurement tool. Expected shortfall (ES) is suggested as a better alternative to use during market turmoil. What should be understood regarding VaR and ES before modifying current practices?

- A. Despite being more complicated to calculate, ES is easier to backtest than VaR.
- B. Relative to VaR, ES leads to more required economic capital for the same confidence level.
- C. While VaR ensures that the estimate of portfolio risk is less than or equal to the sum of the risks of that portfolio's positions, ES does not.
- D. Both VaR and ES account for the severity of losses beyond the confidence threshold.

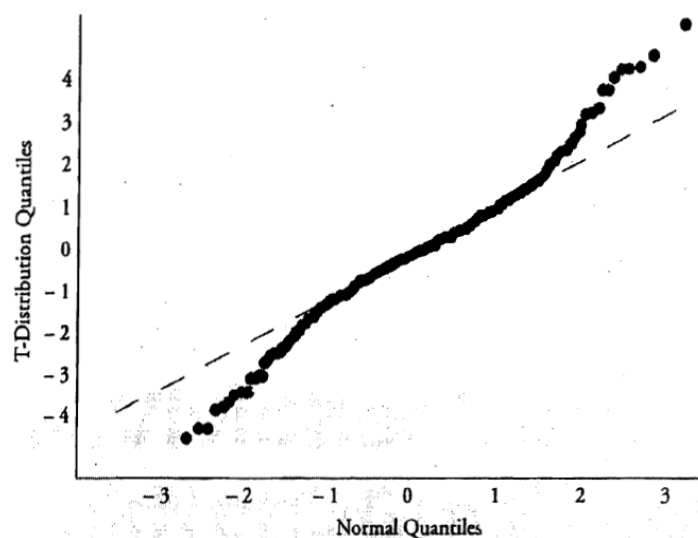
Answer: B

Expected shortfall is always greater than or equal to VaR for a given confidence level, since ES accounts for the severity of expected losses beyond a particular confidence level, while VaR measures the minimum expected loss at that confidence level. Therefore, ES would lead to a higher level of required economic capital than VaR for the same confidence level. In practice, however, regulators often correct for the difference between ES and VaR by lowering the required confidence level for banks using ES compared to those using VaR.

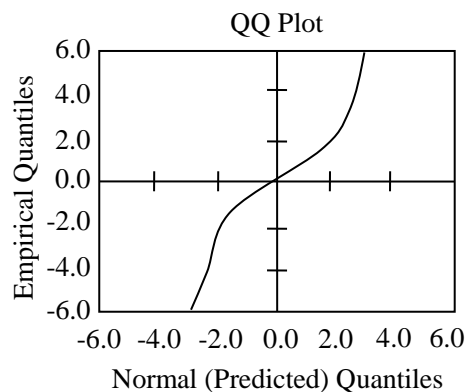
Key Point: Quantile-Quantile Plots

The quantile-quantile (QQ) plot is a visual inspection of an empirical quantile relative to a hypothesized theoretical distribution. If the empirical distribution closely matches the theoretical distribution, the QQ plot would be linear.

Figure 3: QQ Plot



12. Consider the following QQ plot:



Which is the most likely true statement about the QQ plot?

- A. The empirical distribution is actually parametric.
- B. The empirical distribution has positive skew.
- C. The empirical distribution has leptokurtosis ($kurtosis > 0$)
- D. If we perform a linear transformation of location and scale, the distribution is approximately normal.

Answer: C

Heavy tails: the steeper slope - i.e., greater than 1.0 - at the tails indicates the tails are heavier than the reference distribution

13. An analyst is examining a sample of return data. As a first step, the analyst construct a QQ plot of the data as shown below:

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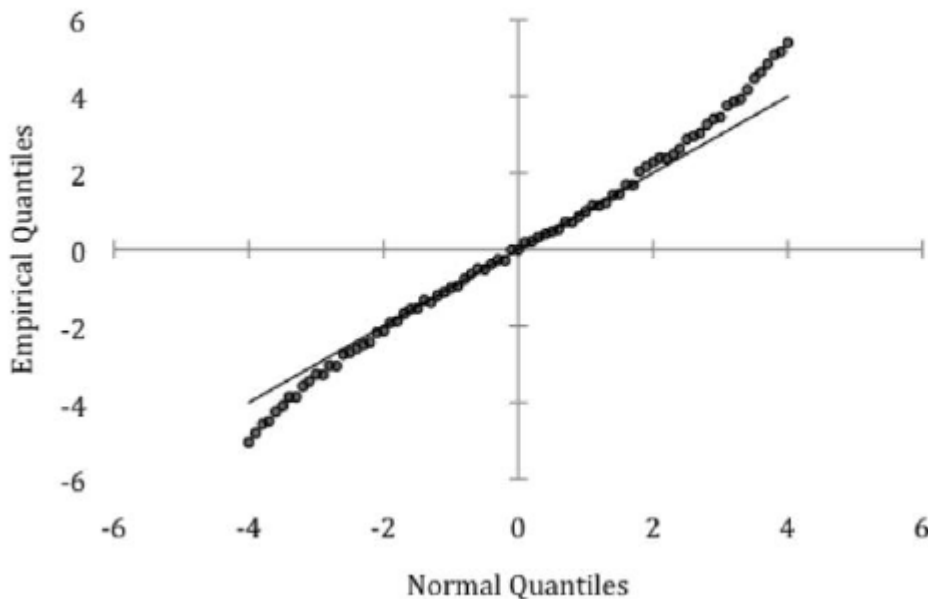
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Based on an examination of the QQ plot, which of the following statements is correct?

- A. The returns are normally distributed.
- B. The return distribution has thin tails relative to the normal distribution.
- C. The return distribution is negatively skewed relative to the normal distribution.
- D. The return distribution has fat tails relative to the normal distribution.

Answer: D

Explanation: This Q-Q plot has steeper slopes at the tails of the plot, which indicate fat tails in the distribution. A normal distribution would result in a linear QQ plot. A distribution with thin tails would produce a QQ plot with less steep slopes at the tails of the plot than a linear relationship, while this one is steeper at the tails. It is not a negatively skewed distribution, as the Q-Q plot is symmetric.

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.

14. 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.

15. 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 sub-additive. This is an undesirable property because it creates disincentives to aggregate the portfolio, since it appears to have higher risk.

16. Which of the following statements comparing VaR with expected shortfall is true?

- A. Expected shortfall is sub-additive while VaR is not.
- B. Both VaR and expected shortfall measure the amount of capital an investor can expect to lose over a given time period and are, therefore, interchangeable as risk measures.
- C. Both VaR and expected shortfall depend on the assumption of a normal distribution of returns.
- D. VaR can vary according to the confidence level selected, but expected shortfall will not.

Answer: A

VaR measures the expected amount of capital one can expect to lose within a given confidence level over a given period of time. One of the problems with VaR is that it does not provide information about the expected size of the loss beyond the VaR. VaR is often complemented by the expected shortfall, which measures the expected loss conditional on the loss exceeding the VaR. Note that since expected shortfall is based on VaR, changing the confidence level may change both measures. A key difference between the two measures is that VaR is not sub-additive, meaning that the risk of two funds separately may be lower than the risk of a portfolio where the two funds are combined. Violation of the sub-additive assumption is a problem with VaR that does not exist with expected shortfall.

17. Assume that an operational process has a 5% probability of creating a material loss and, otherwise, no material loss is experienced (i.e., Bernoulli). If the material loss occurs, the severity is normally distributed with a mean of \$4 million and standard deviation of \$2 million. What is the 95% expected shortfall?

- A. \$0.71 million
- B. \$3.29 million

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C. \$4.00 million

D. \$7.29 million

Answer: C

$ES = E(L | L > VaR)$. In this case, the 95% ES is the expected loss conditional on the loss occurring, which coincides with the mean of the normal distribution.

18. Assume position (X) contains risk of $R(X)$ and position (Y) contains risk of $R(Y)$. Our analysis finds that the risk of the combined portfolio $R(X+Y)$ is greater than the sum of the individual positions risks; i.e., we find $R(X+Y) > R(X) + R(Y)$. This illustrates a violation of which coherence property?

A. Monotonicity

B. Subadditivity

C. Positive Homogeneity

D. Translational invariance

Answer: B

The diversification should make the portfolio less risky, or at the very least, equally risky. But the combination should not penalize diversification in terms of the risk metric.

19. Which of the following is a true statement about expected shortfall (ES)?

A. ES is a coherent spectral measure which gives equal weight to the tail quantiles

B. ES is a coherent spectral measure which gives increasingly greater weight to higher tail quantiles

C. ES is a coherent spectral measure but gives decreasingly less weight to higher tail quantiles

D. ES is coherent, VaR is not coherent, and neither are spectral measures

Answer: A

ES is a coherent spectral measure which gives equal weight to the tail quantiles. The general class is spectral measures, which contain a weighting function. Both ES and VaR are special cases of a spectral measure (the spectral function generalized both ES & VaR). Spectral measures are coherent under conditions that are met by ES but not by VaR; “Spectral” is associated with, but does not necessarily imply, coherence.

Key Point: Non-Parametric Approach (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

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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.

20. 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?
- Filter the data to remove the obvious outliers.
 - Repeated sampling with replacement.
 - Identify the tail region from reordering the original data.
 - 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.

21. 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 historical simulation approach is most accurate?
- The age-weighted procedure incorporate estimates from GARCH model.
 - If the decay factor in the model is close to 1, there is persistence within the data set.
 - 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.

22. If volatility (0) is the current (today's) volatility estimate and volatility (t) is the volatility estimate on a previous day (t), which best describes volatility-weighted historical simulation?
- A. First conduct typical historical simulation (HS) on return series. Then multiply VaR by volatility(0)/volatility(t)
 - B. First conduct typical historical simulation (HS) on return series. Then multiply VaR by volatility(t)/volatility(0)
 - C. Each historical return (t) is replaced by: return (t)*volatility (0)/volatility (t). Then conduct typical historical simulation (HS) on adjusted return series.
 - D. Each historical return (t) is replaced by: return (t)*volatility (t)/volatility (0). Then conduct typical historical simulation (HS) on adjusted return series.

Answer: C

Each historical return (t) is replaced by: return(t) \times volatility(0)/volatility(t). Then conduct typical historical simulation (HS) on adjusted return series

For example, if on the historical day (t), the return(t) was -2.0% and volatility(t) was 10%, while today's volatility estimate is 20%, then the adjusted return is $-2.0\% \times 20\%/10\% = -4.0\%$. In this way, "Actual returns in any period t are therefore increased (or decreased), depending on whether the current forecast of volatility is greater (or less than) the estimated volatility for period t. We now calculate the HS P/L using [the adjusted returns] instead of the original data set, and then proceed to estimate HS VaRs or ESs in the traditional way (i.e., with equal weights, etc.).

23. All of the following approaches improve the traditional historical simulation approach for estimating VaR except the:
- A. Volatility-weighted historical simulation.
 - B. Age-weighted historical simulation.
 - C. Market-weighted historical simulation.
 - D. Correlation- weighted historical simulation.

Answer: C

Market-weighted historical simulation is not discussed in this topical. Age-weighted historical simulation weights observations higher when they appear closer to the event date.

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Volatility-weighted historical simulation adjusts for changing volatility levels in the data. Correlation-weighted historical simulation incorporates anticipated changes in correlation between assets in the portfolio.

24. Which of the following statements about volatility-weighting is true?

- A. Historic returns are adjusted, and the VaR calculation is more complicated.
- B. Historic returns are adjusted, and the VaR calculation procedure is the same.
- C. Current period returns are adjusted, and VaR calculation is more complicated.
- D. Current period returns are adjusted, and VaR calculation is the same.

Answer: B

The volatility-weighting method adjusts historic returns for current volatility. Specifically, return at time t is multiplied by (current volatility estimate/ volatility estimate at time t). However, the actual procedure for calculating VaR using a historical simulation method is unchanged; it is only the inputted data that changes.

25. All of the following items are generally considered advantages of non-parametric estimation methods except:

- A. Ability to accommodate skewed data.
- B. Availability of data.
- C. Use of historical data.
- D. Little or no reliance on covariance matrices.

Answer: C

The use of historical data in non-parametric analysis is a disadvantage, not an advantage. If the estimation period was quiet (volatile) then the estimated risk measures may understate (overstate) the current risk level. Generally, the largest VaR cannot exceed the largest loss in the historical period. On the other hand, the remaining choices are all considered advantages of non-parametric methods. For instance, the non-parametric nature of the analysis can accommodate skewed data, data points are readily available, and there is no requirement for estimates of covariance matrices.

Key Point: Modeling Dependence: Correlations and Copulas

$$\text{Correlation: } \rho(X, Y) = \frac{\text{Cov}(X, Y)}{\sigma(X)\sigma(Y)}$$

Spearman's rank correlation:

$$\rho_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)}$$

Kendall's τ :

$$\tau = \frac{n_c - n_d}{n(n-1)/2}$$

Copula:

$$C_{GD}[Q_i(t), \dots, Q_n(t)] = M_n [N^{-1}(Q_1(t)), \dots, N^{-1}(Q_n(t)); \rho_M]$$

- $Q_i(t)$: cumulative default probability of asset i at time t
- C_{GD} : Gaussian default time copula
- M_n : the joint, n -variate cumulative standard normal distribution
- ρ_M : the $n \times n$ symmetric, positive-definite correlation matrix of the n -variate normal distribution M_n

26. 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

“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.

27. A risk manager wants to study the behavior of a portfolio that depends on only two economic variables, X and Y . X is uniformly distributed between 4 and 7, and Y is uniformly distributed between 5 and 8. The risk manager wants to model their joint distribution, $H(X, Y)$. The theorem of Sklar proves that, for any joint distribution H , there is a copula C such that:

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- A. $H(3X + 4, 3Y + 5)$ is equal to $C[X, Y]$.
- B. $H(X, Y)$ is equal to $C[u, d]$ where u is the density marginal distribution of X and d is the density marginal distribution of Y .
- C. $H(X, Y)$ is equal to $C[(X - 4)/3, (Y - 5)/3]$.
- D. $H[(X - 4)/3, (Y - 5)/3]$ is equal to $C(X, Y)$.

Answer: C

Explanation: Sklar's theorem proves that if $F(x, y)$ is a joint distribution function with continuous marginal $F_X(x) = u$ and $F_Y(y) = v$, then $F(x, y)$ can be written in terms of a unique function $C(u, v)$ such as $F(x, y) = C(u, v)$. In this case $u = (X - 4)/3$ (the cumulative marginal function of X , which is uniformly distributed between 4 and 7) and $v = (Y - 5)/3$.

28. A risk manager uses the past 480 months of correlation data from the Dow Jones Industrial Average (Dow) to estimate the long-run mean correlation of common stocks and the mean reversion rate. Based on historical data, the long-run mean correlation of Dow stocks was 32%, and the regression output estimates the following regression relationship: $Y = 0.215 - 0.75X$. Suppose that in April 2014, the average monthly correlation for all Dow stocks was 36%. What is the expected correlation for May 2014 assuming the mean reversion rate estimated in the regression analysis?
- A. 32%
- B. 33%
- C. 35%
- D. 37%

Answer: B

There is a -4% difference from the long-run mean correlation and April 2014 correlation ($32\% - 36\% = -4\%$). The inverse of the β coefficient in the regression relationship implies a mean reversion rate of 75%. Thus, the expected correlation for May 2014 is 33.0%:

$$S_t = a(\mu - S_{t-1}) + S_{t-1}$$

$$S_t = 0.75(32\% - 36\%) + 0.36 = 0.33$$

29. A risk manager uses the past 480 months of correlation data from the Dow Jones Industrial Average (Dow) to estimate the long-run mean correlation of common stocks and the mean reversion rate. Based on historical data, the long-run mean correlation of Dow stocks was 34%, and the regression output estimates the following regression relationship: $Y = 0.215 - 0.77X$. Suppose that in April 2014, the average monthly correlation for all Dow stocks was 33%. What is the estimated one-period autocorrelation for this time period based on the mean reversion rate estimated in the regression analysis?

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- A. 23%
- B. 26%
- C. 30%
- D. 33%

Answer: A

The autocorrelation for a one-period lag is 23% for the same sample. The sum of the mean reversion rate (77% given the beta coefficient of -0.77) and the one-period autocorrelation rate will always equal 100%.

30. A risk manager gathers five years of historical returns to calculate the Spearman rank correlation coefficient for stocks X and Y from 2010 to 2014 are as follows:

Year	X	Y
2010	5.0%	-10.0%
2011	50.0%	-5.0%
2012	-10.0%	20.0%
2013	-20.0%	40.0%
2014	30.0%	15.0%

What is the Spearman rank correlation coefficient for stocks returns of X and Y?

- A. -0.7
- B. -0.5
- C. 0.3
- D. 0.7

Answer: A

The following table illustrate the calculation used to determine the sum of squared ranking deviations:

Year	X	Y	X Rank	Y Rank	d_i	d_i^2
2013	-20.0%	40.0%	1	5	-4	16
2012	-10.0%	20.0%	2	4	-2	4
2010	5.0%	-10.0%	3	1	2	4
2014	30.0%	15.0%	4	3	1	1
2011	50.0%	-5.0%	5	2	3	9
					Sum	34

Thus, the Spearman rank correlation coefficient is -0.7:

$$\rho_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)} = 1 - \frac{6 \times 34}{5(25 - 1)} = -0.7$$

31. The dependence structure between the returns of financial assets plays an important role in risk measurement. For liquid markets, which of following statements is incorrect?
- A. Correlation is a valid measure of dependence between random variables for only certain types of return distributions.
 - B. Even if the return distributions of two assets have a correlation of zero, the returns of these assets are not necessarily independent.
 - C. Copulas make it possible to model marginal distributions and the dependence structure separately.
 - D. With short time horizons (3 months or less), correlation estimates are typically very stable.

Answer: D

Correlation estimates tend to be very volatile when short term time horizons are considered.

32. The long-term mean of the correlation data is 35%. In January 2014, the averaged correlation of the 30×30 Dow correlation matrices was 27%. From the regression function from 1972 to 2012, the average mean reversion was 77.5%. Using the simple $s(t) - s(t-1) = \alpha \times [\mu - s(t-1)]$ model, what is the expected correlation for February 2014?
- A. 27.75%
 - B. 28.80%
 - C. 33.20%
 - D. 37.50%

Answer: C

$$33.20\% = 27.0\% + 77.5\% \times (35.0\% - 27.0\%)$$

33. The annual returns of two assets, $X(i)$ and $Y(i)$, are shown below for the five years from 2010 to 2103. The returns have been sorted with respect to $X(i)$; for example, in 2010 $X(i)$ returned 6.0% which ranked 4th among its annual returns (ranking is from worst to best). The Pearson correlation coefficient, taken from the actual return pairs - for example, $(X, Y) = (-12.5\%, 4.3\%)$ - is about 0.756. But we are interested instead in a rank correlation. Which is nearest to the Spearman's rank correlation?
- A. 0.25
 - B. 0.33
 - C. 0.60
 - D. 0.85

Year	Ranked Return of $X(i)$	Assigned (same year) Return of $Y(i)$
2013	-12.5%	4.3%

2011	-9.6%	2.5%
2010	4.3%	6.0%
2014	8.7%	6.2%
2012	16.0%	5.5%

Answer: C

Spearman's rank correlation = $1 - (6 \times [\text{sum of } d(i)^2] / [n(n^2-1)]) = 1 - (6 \times 8) / [5 \times (5^2 - 1)] = 1 - 48/120 = 0.60$

34. What is a copula function?

- A. A copula correlates a stock price and its volatility which allows it to model equity implied volatility skew.
- B. A copula function joins univariate distribution to one multivariate distribution.
- C. A copula function solve for the conditional $P[X|Y]$ as function of the product of $P[Y|X]$ and the ratio of marginal probabilities $P[X]/P[Y]$.
- D. A copula function is a limiting (special) case of the Pearson model, such that it only analyzes linear relationship between variables.

Answer: B

A copula function joins (n) univariate distributions to one multivariate (n-dimensional) distribution

In regard to false (A), this refers to the original Heston (1993) model.

In regard to false (C), this is a Bayes Theorem

In regard to false (D), this refers to the binomial correlation model

35. About correlation measures including Pearson's, Spearman's and Kendall's tau, each of the following is true except which is false?

- A. Pearson is a cardinal correlation measure while Spearman's and Kendall's tau are ordinal correlation measures.
- B. The problem with applying ordinal rank correlations to cardinal observations is that ordinal correlation are less sensitive to outliers (an unwelcome property in risk management)
- C. An advantage of Pearson's correlation coefficient is that it is invariance to transformations: e.g., Pearson's correlation between pairs $[x, y]$ will equal Pearson's correlation between $[\ln(x), \ln(y)]$
- D. Pearson's correlation coefficient is a natural (good) dependence measure when variables are distributed as multivariate elliptical (e.g., normal, student's t); however, we know many financial variables are not elliptically distributed.

Answer: C

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False. Pearson's is strictly not invariant to transformation. For example, Pearson's correlation between pairs $[x, y]$ will not equal Pearson's between $[\ln(x), \ln(y)]$. In regard to (A), (B) and (D), each is TRUE.

36. In estimating correlation matrices, risk managers often assume an underlying distribution for the correlations. Which of the following statements most accurately describes the best fit distributions for equity correlation distributions, bond correlation distributions, and default probability distribution? The best fit distribution for the equity, bond, and default probability correlation distributions, respectively are:

- A. Lognormal, generalized extreme value, and normal.
- B. Johnson SB, generalized extreme value, and Johnson JB.
- C. Beta, normal, and beta.
- D. Johnson SB, normal, and beta.

Answer: B

Equity correlation distributions and default probability correlation distributions are best fit with the Johnson SB distribution. Bond correlation distributions are best fit with the generalized extreme value distribution.

37. A risk manager is using a copula correlation model to perform stress tests of financial risk during systemic economic crises. If the risk manager is concerned about extreme outliers, which of the following correlation coefficient measures should be used?

- A. Kendall's τ correlation
- B. Ordinal correlation
- C. Pearson correlation
- D. Spearman's rank correlation

Answer: C

The Pearson correlation coefficient is preferred to ordinal measures when outliers are a concern. Spearman's rank correlation and Kendall's τ are ordinal correlation coefficients that should not be used with cardinal financial variables because they underestimate risk by ignoring the impact of outliers.

Key Point: Backtesting VaR

Using Failure Rates in Model Verification N/T

H_0 : accurate model

H_a : inaccurate model

Test statistic:

$$LR_{uc} = -2\ln\left[(1-p)^{T-N} p^N\right] + 2\ln\left\{1 - (N/T)^{T-N} (N/T)^N\right\}$$

- P: the probability of exception, $p=1-c$
- N: the number of exceptions
- T: the number of samples

If $LR > 3.84$, we would reject the hypothesis that the model is correct.

$$MRC_t^{IMA} = \text{Max} \left(k \frac{1}{60} \sum_{i=1}^{60} \text{VAR}_{t-i}, \text{VAR}_{t-1} \right) + \text{SRC}_t$$

Basel Penalty Zones		
Zone	Number of Exceptions	Multiplier(k)
Green	0 to 4	3.00
Yellow	5	3.40
	6	3.50
	7	3.65
	8	3.75
	9	3.85
Red	10 or more	4.00

38. Which of the following statements regarding verification of a VaR model by examining its failure rates is false?

- The frequency of exceptions should correspond to the confidence level used for the model.
 - According to Kupiec (1995), we should reject the hypothesis that the model is correct if the $LR > 3.84$.
 - Backtesting VaR models with lower confidence levels is difficult because the number of exceptions is not high enough to provide meaningful information.
 - 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)
- I and IV
 - II only
 - III only
 - II and IV

Answer: C

Backtesting VaR models with higher confidence levels is difficult because the number of

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exceptions is not high enough to provide meaningful information.

39. Basel II requires a backtest of a bank's internal value at risk (VaR) model (IMA). Assume the bank's ten-day 99% VaR is \$1 million (minimum of 99% is hard-wired per Basel). The null hypothesis is: the VaR model is accurate. Out of 1,000 observations, 25 exceptions are observed (we saw the actual loss exceed the VaR 25 out of 1000 observations). (Binomial CDF)
- A. We will probably call the VaR model good (accurate) but we risk a Type I error.
 - B. We will probably call the VaR model good (accurate) but we risk a Type II error.
 - C. We will probably call the model bad (inaccurate) but we risk a Type I error.
 - D. We will probably call the model bad (inaccurate) but we risk a Type II error.

Answer: C

The probability of 25 or more exceptions will only be observed 1 – 99.996%. So, we reject the model.

Null = good model. To decide the model is bad model is to reject null and this implies a risk of type I error.

40. A bank conducted a backtest of its 95% daily value at risk (VaR) and observed 19 exceptions - i.e., the number of days where the daily P&L loss exceeded the VaR - over the last year which included 250 trading days ($T = 250$). If we use the normal distribution to approximate the binomial for purposes of model verification, what is our accept/reject opinion of the model under a 90% two-tailed test?
- A. Accept with a test statistic of 1.25
 - B. Accept with a test statistic of 1.89
 - C. Reject with a test statistic of 1.25
 - D. Reject with a test statistic of 1.89

Answer: D

Null hypothesis is H_0 : Model is good with $E[\text{exceptions}] = (1 - 95\%) \times 250 = 12.5$ exceptions

The standard error (standard deviation) of the binomial variable = $\text{SQRT}[p(1-p)T] = \text{SQRT}(5\% \times 95\% \times 250) = 3.446$

The test statistic is $[19 - 12.5] / 3.446 = 1.89$

In words, we observed 6.5 more exceptions (19 - 12.5) than expected if the model is good, which is 1.89 standard deviations away from the expected number of exceptions. Since we know that a 95% one-tailed normal confidence interval implies a 1.645 cutoff, we know that 1.645 is also the cutoff for a 90% two-tailed since the normal is symmetrical, this falls outside the acceptance region. We reject the null, assuming that luck does not explain this, and find the model faulty.

41. You are backtesting a bank's VaR model. Currently, the bank calculates a 1-day VaR at the 99% confidence level, and you are recommending that it switch to a 95% confidence level. Which of the following statements concerning this switch is correct?
- A. The 95% VaR model is less likely to be rejected using backtesting than the 99% VaR model.
 - B. When validating with backtesting at the 90% confidence level, there is a smaller probability of incorrectly rejecting a 95% VaR model when it is valid than a 99% VaR model.
 - C. The decision to accept or reject a VaR model based on backtesting results is more reliable with a 95% confidence level VaR model than with a 99% confidence level model.
 - D. When backtesting using a 90% confidence level, there is a smaller probability of committing a type I error when backtesting a 95% VaR model than with a 99% VaR model.

Answer: C

The concept tested here is the understanding of the difference between the VaR parameter for confidence (here, namely 95% vs 99%) and the validation procedure confidence level, and how they interact with one another. Using a VaR confidence level creates a narrower rejection region by allowing a greater number of exceptions to be generated. This in turn increases the power of the backtesting process and makes for a more reliable test.

42. Based on Basel II rules for backtesting, a penalty is given to banks that have more than four exceptions to their 1-day 99% VaR over the course of 250 trading days. The supervisor gives these penalties based on four criteria. Which of the following causes of exceptions is most likely to lead to a penalty?
- A. The bank increases its intraday trading activity.
 - B. A large move in interest rates was combined with a small move in correlations.
 - C. The bank's model calculates interest rate risk based on the median duration of the bonds in the portfolio.
 - D. A sudden market crisis in an emerging market leads to losses in the equity positions in that country.

Answer: C

In the case of a bank that changed positions more frequently during the day, a penalty should be considered, but it is not necessarily given. In the case of bad luck, no penalty is given, as would be the case for a bank affected by unpredictable movements in rates or markets. However, when risk models are not precise enough, a penalty is typically given since model accuracy could have easily

been improved.

43. A risk manager is analyzing a 1-day 99% VaR model. Assuming 225 days in a year, what is the maximum number of daily losses exceeding the 1-day 99% VaR that is acceptable in a 1-year backtest to conclude, at a 95% confidence level, that the model is calibrated correctly?

- A. 3
- B. 5
- C. 8
- D. 10

Answer: B

The risk manager will reject the hypothesis that the model is correctly calibrated if the number x of losses exceeding the VaR is such that:

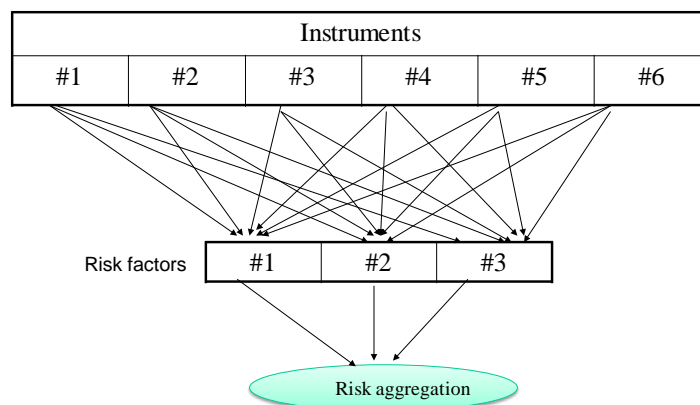
$$\frac{x - pT}{\sqrt{p(1-p)T}} > z = 1.96$$

where p represents the failure rate and is equal to $1 - 99\%$, or 1% ; and T is the number of observations = 225. And $z = 1.96$ is the two-tail confidence level quantile. If:

$$\frac{x - 0.01 \times 225}{\sqrt{0.01 \times (1 - 0.01) \times 225}} = 1.96$$

Then, $x = 5.18$. So the maximum number of exceedances would be 5 to conclude that the model is calibrated correctly.

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.

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- 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:

$$\text{VaR}(dP) = |-D^*P| \times \text{VaR}(dy)$$

Mapping Approaches for Nonlinear Derivatives

Delta-Gamma method:

$$\text{VAR}(df) = |\Delta| \times \text{VAR}(dS) - (1/2)\Gamma \times \text{VAR}(dS)^2$$

44. 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?
- \$30,000 and 1,030,000
 - \$29,500 and 975,610
 - \$29,703 and 1,004,878
 - \$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:

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

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

45. Which of the following can be considered a general risk factor?
- Exchange rate
 - Mortgage-backed securities
 - Zero-coupon bond
 - Interest rate
- I only
 - II and III
 - III only

D. I and IV

Answer: D

46. 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.

47. Under these assumptions - in particular: a flat yield curve and constant yield volatility of 1.0% - why can we expect cash flow mapping to produce a lower diversified VaR than either duration and principal mapping?

- A. The risk measures are non-linear.
- B. Due to imperfect correlations between pairwise risk factors.
- C. Fewer total cash flows will be mapped.
- D. We cannot expect a lower diversified VaR.

Answer: B

The diversified VaR is lower due to two factors. First, risk measures are not perfectly linear with maturity. Second, correlations are below unity, which reduces risk even further.

48. In fixed income portfolio mapping, when the risk factors have been selected, which of the following mapping approaches requires that one risk factor be chosen that corresponds to average portfolio maturity?

- A. Principal mapping
- B. Duration mapping
- C. Convexity mapping
- D. Cash mapping

Answer: A

Explanation: With principal mapping, one risk factor is chosen that corresponds to the average portfolio maturity. With duration mapping, one risk factor is chosen that corresponds to the portfolio duration. With cash flow mapping, the portfolio cash flows are grouped into maturity buckets. Convexity mapping is not a method of VaR mapping for fixed income portfolios.

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49. Which of these statements regarding risk factor mapping approaches is/are correct?
- I. Under the cash flow mapping approach, only the risk associated with the average maturity of a fixed-income portfolio is mapped.
 - II. Cash flow mapping is the least precise method of risk mapping for a fixed-income portfolio.
 - III. Under the duration mapping approach, the risk of a bond is mapped to a zero-coupon bond of the same duration.
 - IV. Using more risk factors generally leads to better risk measurement but also requires more time to be devoted to the modeling process and risk computation.
- A. I and II
 - B. I, III, and IV
 - C. III and IV
 - D. IV only

Answer: C

Under the cash flow mapping approach, each payment (and not only the last one) is associated with a different risk factor, so statement I. is incorrect. Statement II. is incorrect because the CF mapping approach is more correct than duration or maturity mapping.

50. There is a short position in 1-year bonds with a \$150 million face value and a 6% annual interest rate, with interest paid semiannually. The annualized interest rate on zero-coupon bonds is 3.8% for a 6-month maturity and 4.1% for a 12-month maturity. Decompose the bond into the cash flows of the two standard instruments. What are the present values of each cash flow?

PV of CF1	PV of CF2
A. - \$4,117,945	-\$139,882,651
B. - \$4,226,094	-\$143,873,919
C. - \$4,416,094	-\$148,355,095
D. - \$4,879,542	-\$144,224,783

Answer: C

The standard instruments are $-150,000,000 \times 0.06/2 = \$4,500,000$ for six months, and

$-\$4,500,000 - 150,000,000 = -\$154,500,000$ for 12 months.

The present values are $-\$4,500,000/1.019 = -\$4,416,094$ and $-\$154,500,000/(1 + 0.041/2)^2 = -\$148,355,095$.

51. Computing VaR on a portfolio containing a very large number of positions can be simplified by mapping these positions to a smaller number of elementary risk factors. Which of the following mappings would be adequate?

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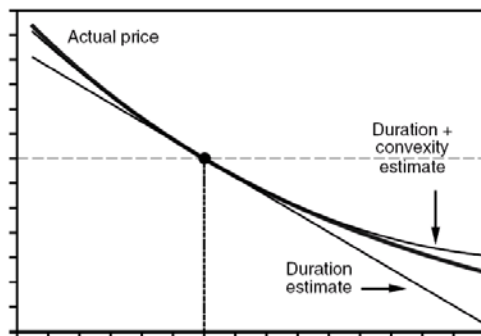
- A. USD/EUR forward contracts are mapped on the USD/JPY spot exchange rate.
- B. Each position in a corporate bond portfolio is mapped on the bond with the closest maturity among a set of government bonds.
- C. Government bonds paying regular coupons are mapped on zero-coupon government bonds.
- D. A position in the stock market index is mapped on a position in a stock within that index.

Answer: C

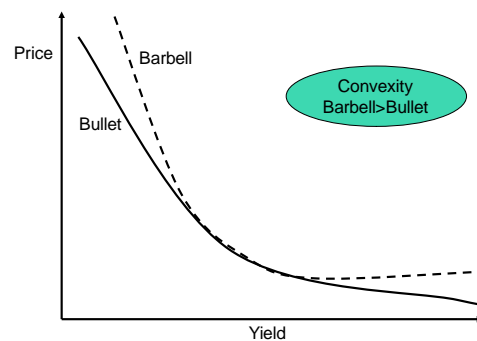
Mapping government bonds paying regular coupons onto zero coupon government bonds is an adequate process, because both categories of bonds are government issued and therefore have a very similar sensitivity to risk factors. However, this is not a perfect mapping since the sensitivity of both classes of bonds to specific risk factors (i.e., changes in interest rates) may differ.

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

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



Barbell vs. Bullet



If a bullet and barbell have the same duration, the barbell portfolio will have greater convexity because convexity is related to the square of maturity.

52. John Snow's 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

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

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

53. 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.

54. Given the following bond portfolios:

Bond Maturity	Portfolio 1 Duration Contribution	Portfolio 2 Duration Contribution
2-year bonds	1.32	0.52
5-year bonds	1.37	3.18
10-year bonds	3.95	1.05
20-year bonds	1.51	3.40
Effective portfolio duration	?	?

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

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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: Interest Rate Tree (Binominal) 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.

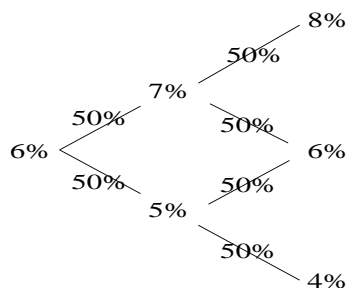
There are three basic steps to valuing an option on a fixed-income instrument using a binomial tree:

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.

55. Suppose investors have interest rate expectations as illustrated in the decision tree below where the 1-year rate is expected to be 8%, 6%, or 4% in the second year and either 7% or 5% in the first year for a zero-coupon bond.



If investors are risk-neutral, what is the price of a \$1 face value 2-year zero-coupon bond today?

- A. \$0.88113
- B. \$0.88634
- C. \$0.89007
- D. \$0.89032

Answer: C

$$\left(\frac{1}{1+7\%} \times 50\% + \frac{1}{1+5\%} \times 50\% \right) / (1+6\%) = 0.89007$$

56. 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 closet 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:

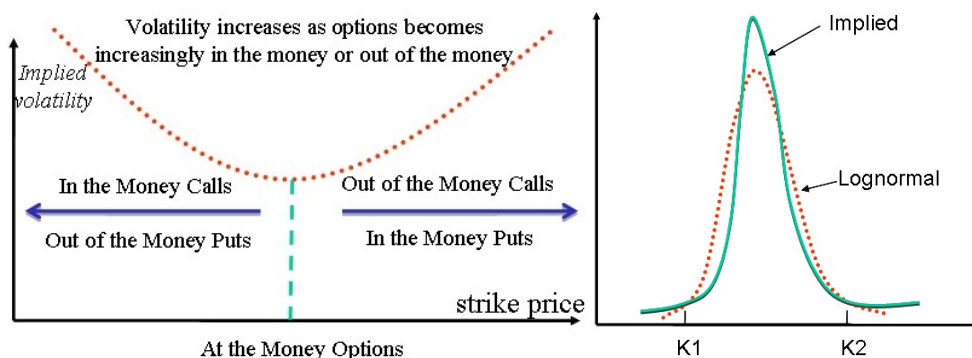
$$\frac{(\$1.52 \times 0.76) + (\$0.22 \times 0.24)}{1.0300} = \$1.17$$

Key Point: Volatility Smile

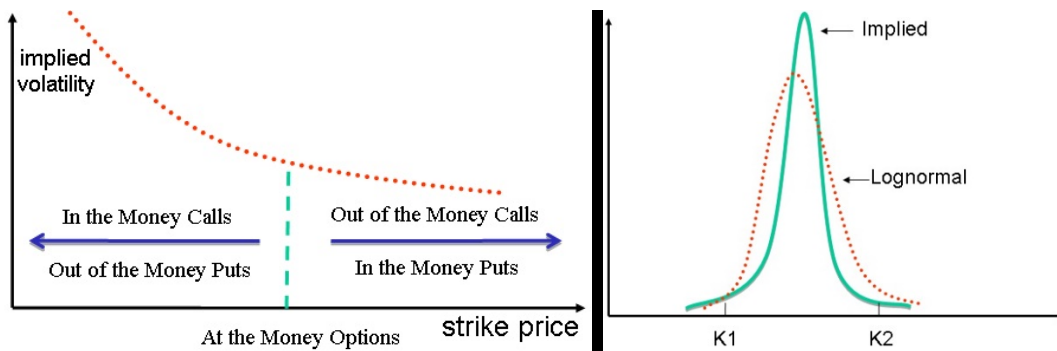
Put-call parity indicates that the deviation between market prices and Black-Scholes-Merton prices will be equivalent for calls and puts. Hence, implied volatility will be the same for calls and puts.

$$p_{BS} - p_{mkt} = c_{BS} - c_{mkt}$$

For foreign exchange options:



For stock options:



57. 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)?
- ES with the updated models will be larger than the old estimate.
 - ES with the updated models will be smaller than the old estimate.
 - ES will remain unchanged.
 - Insufficient information to determine.

Answer: A

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.

58. 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:
- Short position in an at-the-money call
 - Long position in an at-the-money call
 - Short position in a deep in-the-money call
 - 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.

59. 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.

60. 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?

- A. Use the implied volatility of at-the-money options because the estimation of the volatility is more reliable.
- B. 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.
- C. For each option, use the implied volatility of the most similar option traded on the market.
- D. Use the historical volatility because doing so corrects for the pricing mistakes in the option market.

Answer: C

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

61. 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?

- A. \$1.50

- B. \$2.00
- C. \$1.00
- D. \$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

62. An empirical distribution of equity price derived from the price of options of such stock based on BSM that exhibits a fatter right tail than that of a lognormal distribution would indicate:
- A. Equal implied volatilities across low and high strike prices.
 - B. Greater implied volatilities for low strike prices.
 - C. Greater implied volatilities for high strike prices.
 - D. Higher implied volatilities for mid-range strike prices.

Answer: C

Explanation: An empirical distribution with a fat right tail generates a higher implied volatility for higher strike prices due to the increased probability of observing high underlying asset prices.

63. Which of the following statements is true regarding volatility smiles?
- I. Currency options exhibit volatility smiles because at the money options have higher implied volatility than away from the money options.
 - II. Volatility frowns result when jumps occur in asset prices.
 - III. Equity options exhibit a volatility smirk because low strike price options have greater implied volatility.
 - IV. Relative to currency traders, it appears that equity trader's expectations of extreme price movements are more asymmetric.
- A. I and II
 - B. I and IV
 - C. II and III
 - D. II, III, and IV

Answer: D

64. Compared to at-the-money currency options, out-of-the-money currency options exhibit

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which of the following volatility traits?

- A. Lower implied volatility
- B. A frown
- C. A smirk
- D. Higher implied volatility

Answer: D

Away-from-the-money currency options have greater implied volatility than at-the-money currency options, this pattern in a volatility smile.

65. Which of the following statement is incorrect regarding volatility smiles?

- A. Currency options exhibit volatility smiles because the at-the-money option have higher implied volatility away-from-the-money options.
- B. Volatility frowns result when jumps occur in asset prices
- C. Equity options exhibit a volatility smirk because low strike price options have grater implied volatility.
- D. Relative to currency traders, it appears that equity traders' expectations of extreme price movements are more asymmetric.

Answer: A

Currency options exhibit volatility smiles because the at-the-money options have lower implied volatility than away-from-the-money options.

Equity traders believe that the probability of large price decrease is greater than the probability of large price increase. Currency trades' beliefs about volatility are more symmetric as there is no large skew in the distribution of expected currency values (i.e. there is a greater chance of large price movements in either direction).

66. A risk manager is examining a firm's equity index option price assumptions. The observed volatility skew for a particular equity index slopes downward to the right. Compared to the lognormal distribution, the distribution of option prices on this index implied by the Black-Scholes-Merton (BSM) model would have:

- A. A fat left tail and a thin right tail.
- B. A fat left tail and a fat right tail.
- C. A thin left tail and a fat right tail.
- D. D .A thin left tail and a thin right tail.

Answer: A

A downward sloping volatility skew indicates that out of the money puts are more expensive than predicted by the Black-Scholes-Merton model and out of the money calls are cheaper than expected predicted by the Black-Scholes-Merton model. The implied distribution has fat left tails

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and thin right tails.

67. A committee of risk management practitioner discusses the difference between pricing deep out-of-the-money call options on FBX stock and pricing deep out-of-the-money call options on the EUR/JPY foreign exchange rate using the Black-Scholes-Merton (BSM) model. The practitioners price these options based on two distinct probability distributions of underlying asset prices at the option expiration date:

- A lognormal probability distribution
- An implied risk-neutral probability distribution obtained from the volatility smile for options of the same maturity

Using the lognormal instead of the implied risk-neutral probability distribution will tend to:

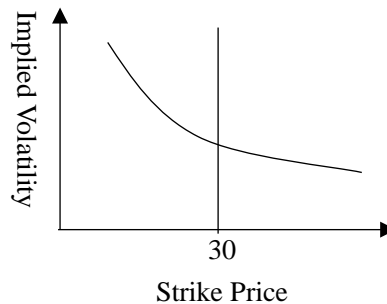
- A. Price the option on FBX relatively high and price the option on EUR/JPY relatively low.
- B. Price the option on FBX relatively low and price the option on EUR/JPY relatively high.
- C. Price the option on FBX relatively low and price the option on EUR/JPY relatively high.
- D. Price the option on FBX relatively high and price the option on EUR/JPY relatively high.

Answer: A

The implied distribution of the underlying equity prices derived using the general volatility smile of equity options has a heavier left tail and a less heavy right tail than a lognormal distribution of underlying prices. Therefore, using the lognormal distribution of prices causes deep-out-of-the-money call options on the underlying to be priced relatively high.

The implied distribution of underlying foreign currency prices derived using the general volatility smile of foreign currency options has heavier tail than a lognormal distribution of underlying prices. Therefore, using the lognormal distribution of prices causes deep-out-of-the-money call options on the underlying to be priced relatively low.

68. A risk manager is in the process of valuing several European option positions on a non-dividend-paying stock XYZ that is currently priced at GBP 30. The implied volatility skew, estimated using the Black-Scholes-Merton model and the current prices of actively traded European-style options on stock XYZ at various strike prices, is



Assuming that the implied volatility at GBP 30 is used to conduct the valuation, which of the following long positions will be undervalued?

- A. An out-of-the-money call
- B. An in-the-money call
- C. An at-the-money put
- D. An in-the-money put

Answer: B

An in-the-money call has a strike price below 30. Therefore, using the chart above, its implied volatility is greater than the at-the-money volatility, so using the at-the-money volatility would result in pricing an in-the-money call option lower than its fair price.

Key Point: Empirical Approaches to Risk Metrics and Hedge

Denoting the face amounts of the real and nominal bonds by F^R and F^N and their DV01s by $DV01^R$ and $DV01^N$, the regression-based hedge, characterized earlier as the DV01 hedge adjusted for the average change of nominal yields relative to real yields, can be written as follows:

$$F^R = -F^N \times \frac{DV01^N}{DV01^R} \times \hat{\beta}$$

The hedge of the first equation minimizes the variance of the P&L in over the data set and used to estimate the regression parameters.

69. Assume that a trader is making a relative value trade, selling a U.S. Treasury bond and correspondingly purchasing a U.S. Treasury TIPS. Based on the current spread between the two securities, the trader shorts \$100 million of the nominal bond and purchases \$89.8 million of TIPS. The trader then starts to question the amount of the hedge due to changes in yields on TIPS in relation to nominal bonds. He runs a regression and determines from the output that the nominal yield changes by 1.0274 basis points per basis point change in the real yield. Would the trader adjust the hedge, and if so, by how much?
- A. No
 - B. Yes, by \$2.46 million (purchase additional TIPS).

C. Yes, by \$2.5 million (sell a portion of the TIPS).

D. Yes, by \$2.11 million (purchase additional TIPS)

Answer: B

The trader would need to adjust hedge as follows:

$$\$89.8 \text{ million} \times 1.0274 = \$92.26 \text{ million}$$

Thus, the trader needs to purchase additional TIPS worth \$2.46 million.

70. Assume that a trader wishes to set up a hedge such that he sells \$100,000 of a Treasury bond and buys Treasury TIPS as a hedge. Using a historical yield regression framework, assume the DV01 on the T-bond is 0.072, the DV01 on the TIPS is 0.051, and the hedge adjustment factor (regression beta coefficient) is 1.2. What is the face value of the offsetting TIPS position needed to carry out this regression hedge?

A. \$138,462

B. \$169,412

C. \$268,499

D. \$280,067

Answer: B

Defining F^R and F^N as the face amounts of the real and nominal bonds, respectively, and their corresponding DV01 as $DV01^R$ and $DV01^N$, a DV01 hedge is adjusted by the hedge adjustment factor, or beta, as follow:

$$F^R = F^N \times \left[\frac{DV01^N}{DV01^R} \right] \times \beta$$

$$F^R = 100,000 \times \left[\frac{0.072}{0.051} \right] \times 1.2 = 169,412$$

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: λ = 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.

θ = 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:

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

Cox-Ingersoll-Ross (CIR) Model: mean-reverting model with constant volatility, σ , 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, σ , is constant, but basis-point volatility, σ_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

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

Jensen's Inequality

$$E\left(\frac{1}{1+r}\right) > \frac{1}{E(1+r)} = \frac{1}{1+E(r)}$$

71. Model 1 assumes zero drift and is also called a normal model. Model 2 add a term for drift.

Each of the following is true about these two models except for:

- A weakness of Model 1 is that the short-term rate can become negative.
- Model 1 implies a term structure that is perfectly flat at the current rate for all maturities, including the long-term rates.
- Model 2 is more capable of producing an upward-sloping term structure, which is often observed.
- Model 2 is an equilibrium model, rather than an arbitrage-free model, because no attempt is made to match the term structure closely.

Answer: B

Under Model 1, it is true that the middle node recombines to the same current node. But these are future short-term rates; they are not the term structure: the term structure is spot rates at all maturities. Models that take the initial term structure implied by market prices are called arbitrage-free models. A different approach, however, is to start with assumptions about the interest rate process and about the risk premium demanded by the market for bearing interest rate

risk and then derive the risk-neutral process. Models of this sort do not necessarily match the initial term structure and are called equilibrium models.

72. 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).

73. 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:

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

74. 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, λ , 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:

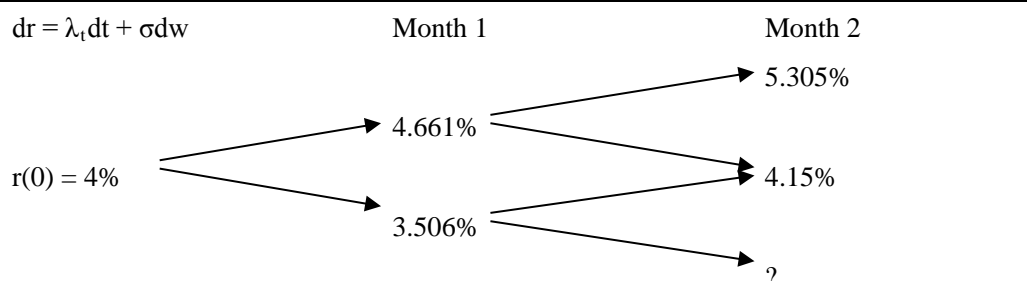
$$5\% - 0.37\% = 4.63\%$$

75. The current short-term rate, $r(0)$ is 4%. Under a Ho-Lee Model with time-dependent drift, the time step is monthly and the annualized drifts are as follows: +100 basis points in the first month and +80 basis points in the second month. The annual basis point volatility is 200bps.

Ho-Lee Assumptions

Month (dt)	0.0833
Annualized drift, first month, λ_1	100 bps
Annualized drift, second month, λ_2	80 bps
Volatility, annual	2%

Ho-Lee Model: Time-dependent drift



What is the value of the missing node [2, 0] in this Ho-Lee interest rate tree?

- A. 2.447%
- B. 2.677%

C. 2.995%

D. 3.256%

Answer: C

$$\text{node}[2,0] = 4\% + (1\% + 0.8\%) \times 1/12 - 2 \times 2\% \times \sqrt{1/12} = 2.995\%$$

76. A risk manager is constructing a term structure model and intends to use the Cox-Ingersoll-Roll model. Which of the following describes this model?

A. The model presumes that the volatility of the short rate will increase at a predetermined rate.

B. The model presumes that the volatility of the short rate will decline exponentially to a constant level.

C. The model presumes that the basis-point volatility of the short rate will be proportional to the rate.

D. The model presumes that the basis-point volatility of the short rate will be proportional to the square root of the rate.

Answer: D

In the CIR model, the basis-point volatility of the short rate is not independent of the short rate as other simpler models assume. The annualized basis-point volatility equals $\sigma\sqrt{r}$ and therefore increases as a function of the square root of the rate.

77. An investor expects the current 1-year rate for a zero-coupon bond to remain at 6%, the 1-year rate next year to be 8%, and the 1-year rate in two years to be 10%. What is the 3-year spot rate for zero-coupon bond with face value of \$1, assuming all investor have the same expectations of future 1-year rates for zero-coupon bonds?

A. 7.888%

B. 7.98%

C. 8.000%

D. 8.088%

Answer: B

The 3-year spot rate can be solved for using the following equation:

$$\frac{\$1}{(1.06)(1.08)(1.10)} = \frac{\$1}{(1+r(3))^3}$$

$$r(3) = \sqrt[3]{(1.06)(1.08)(1.10)} - 1 = 7.988\%$$

78. Suppose an investor expects that 1-year rate will remain at 6% for the first year for a 2-year zero-coupon bond. The investor also projects a 50% probability that the 1-year spot rate will

be 4% in one year. Which of the following inequalities most accurately reflects the convexity for this 2-year bond using Jensen's inequality formula?

- A. $\$0.89031 > \0.89000
- B. $\$0.89000 > \0.80000
- C. $\$0.94340 > \0.89031
- D. $\$0.94373 > \0.94340

Answer: A

The left-hand side of Jensen's inequality is the expected price in one year using the 1-year spot rates of 8% and 4%.

$$E\left(\frac{\$1}{(1+r)}\right) = 0.5 \times \frac{\$1}{(1.08)} + 0.5 \times \frac{\$1}{(1.04)} = 0.5 \times 0.92593 + 0.5 \times 0.96154 = 0.94373$$

The expected price in one year using an expected rate of 6% computes the right-hand side of the inequality as:

$$\frac{\$0.94373}{0.5 \times 1.08 + 0.5 \times 1.04} = \frac{\$1}{1.06} = 0.94340$$

Next, divide each side of the equation by 1.06 to discount 1-year zero-coupon bond price for one more year at 6%. The price of the 2-year zero-coupon bond equals \$0.89031 (calculated as $0.94373/1.06$), which is greater than \$0.89000 (the price of a 2-year zero-coupon bond discounted for two years at the expected rate of 6%). Thus, Jensen's inequality reveal that $\$0.89031 > \0.89000 .

79. Which of the following statements best characterizes the differences between the Ho-Lee model with drift and the lognormal model with drift?

- A. In the Ho-Lee model and the lognormal model the drift terms are multiplicative.
- B. In the Ho-Lee model and the lognormal model the drift terms are additive
- C. In the Ho-Lee model the drift terms are multiplicative, but in the lognormal model the drift terms are additive
- D. In the Ho-Lee model the drift terms are additive, but in the lognormal model the drift terms are multiplicative.

Answer: D

The Ho-Lee model with drift is very flexible, allowing the drift terms each period to vary. Hence, the cumulative effect is additive. In contrast, the lognormal model with drift allows the drift terms to vary, but the cumulative effect is multiplicative.

80. A risk manager is pricing a 10-year Treasuries using a successfully tested pricing model. Current interest rate volatility is high and the risk manager is concerned about the effect this

may have on short-term rates when pricing the option. Which of the following actions would best address the potential for negative short-term interest rates to arise in the model?

- A. The risk manager uses a normal distribution of interest rates.
- B. When short-term rates are negative, the risk manager adjusts the risk-neutral probabilities.
- C. When short-term rates are negative, the risk manager increases the volatility.
- D. When short-term rates are negative, the risk manager sets the rate to zero.

Answer: D

Negative short-term interest rates can arise in models for which the terminal distribution of interest rates follows a normal distribution. The existence of negative interest rates does not make much economic sense since market participants would generally not lend cash at negative interest rates when they can hold cash earn a zero return. One method that can be used to address the potential for negative interest rates when constructing interest rates trees is to set all negative interest rates to zero. This localizes the change in assumptions to points in the distribution corresponding to negative interest rates and preserves the original rate free for all other observations. In comparison, adjusting the risk neutral probabilities would alter the dynamics across the entire range of interest rates and therefore not be an optimal approach.

When a model displays the potential for negative short-term interest rates, it can still be a desirable model to use in certain situations, especially in cases where the valuation depends more on the average path of the interest rate, such as in valuing coupon bonds. Therefore, the potential for negative rates does not automatically rule out the use of the model.

81. An analyst is looking at various models used to incorporate drift into term structure models. The Ho-Lee Model:
- A. Incorporates no-risk premium to the interest rate model allowing rates to vary according to their volatility.
 - B. Incorporates drift as a premium to interest rates that remains constant over time.
 - C. Allows for a risk premium to be applied to interest rates that changes over time.
 - D. Incorporates drift into the model following the assumption that rates revert to the long-run equilibrium value.

Answer: C

Choice c is correct: the Ho-Lee model incorporates a premium to each rate change that can be different at each point in time.

82. A risk manager is constructing a term structure model and intends to use the Cox-Ingersoll-Ross Model. Which of the following describes this model?

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- A. The model presumes that the volatility of the short rate will increase at a predetermined rate.
- B. The model presumes that the volatility of the short rate will decline exponentially to a constant level.
- C. The model presumes that the basis-point volatility of the short rate will be proportional to the rate.
- D. The model presumes that the basis-point volatility of the short rate will be proportional to the square root of the rate.

Answer: D

Explanation: In the CIR model, the basis-point volatility of the short rate is not independent of the short rate as other simpler models assume. The annualized basis-point volatility equals $\sigma\sqrt{r}$ and therefore increases as a function of the square root of the rate.

Key Point: Discount Rate Selection

- Prior to the credit crisis, market participants usually used LIBOR/swap rates as proxies for risk-free rates.
- During the credit crisis, LIBOR rates soared because banks were reluctant to lend to each other.
- Following the credit crisis, most banks have changed their risk-free discount rates to overnight indexed swap (OIS) rates.
- But for non-collateralized transactions they continue to use LIBOR, or an even higher discount rate.
- An overnight indexed swap (OIS) is a swap where a fixed rate for a period (e.g., 1 month or 3 months) is exchanged for the geometric average of the overnight rates during the period.
- The fixed rate in an OIS is referred to as the OIS rate.
- Overnight indexed swaps tend to have relatively short lives (often 3 months or less).
- An OIS lasting longer than 1 year is typically divided into 3-month subperiods.
- At the end of each subperiod the geometric average of the overnight rates during the subperiod is exchanged for the OIS rate.
- The OIS rate is a continually refreshed overnight rate, earned by a financial institution from a series of overnight loans to other financial institutions.

83. The current edition of the monthly research report of an investment bank is dedicated to discussing the risk-free rate and contains the following statements:

"In the United States, rates of Treasury securities may not be considered the best proxy for a risk-free rate because financial institutions are required to purchase Treasury securities due to

various regulatory requirements, which may result in an artificially low yield for these securities. Another proxy for the risk-free rate is LIBOR, which has been increasingly used in collateralized transactions following 2007-2009 financial crisis."

With respect to Treasury securities and LIBOR, are these statements considered accurate?

Treasury securities LIBOR

- | | |
|--------|-----|
| A. No | No |
| B. No | Yes |
| C. Yes | Yes |
| D. Yes | No |

Answer: D

Only the first statement is correct. The second statement is incorrect because LIBOR has been increasingly used in non-collateralized transactions following the 2007-2009 financial crisis.

84. An analyst notes in a presentation to management that the U.S. three-month LIBOR-OIS spread declined from 150 basis points a year ago to 80 basis points today. Regarding this scenario, which of the following statements is considered most accurate?

- A. The decline in spread represents a decline in credit quality in the markets.
- B. A payment of 80 basis points must be made by the floating-rate payer of the OIS.
- C. The LIBOR rate is now a better proxy for the risk-free rate than the OIS rate.
- D. Stress in the financial markets has declined.

Answer: D

The LIBOR-OIS spread is used as a measure of stress in financial markets. A decline in the spread indicates a decline in stress, or an improvement in credit quality, in markets. The spread is not a measure of payment on an overnight indexed swap. The spread also does not imply that the LIBOR rate would be superior to the OIS rate as a proxy for the risk-free rate.

85. Mikey Parizeau, FRM, is a fixed income analyst at a large financial institution. Parizeau states to a colleague that while the OIS rate is not entirely risk-free, it is considered the best proxy for the risk-free rate when used in valuing collateralized derivatives. Is Parizeau's observation correct?

- A. Yes.
- B. No, because the OIS rate is considered entirely risk-free.
- C. No, because the OIS rate is considered the best proxy for the risk-free rate for valuing both collateralized and non-collateralized derivatives.
- D. No, because the OIS rate is considered the best proxy for the risk-free rate for valuing only non-collateralized derivatives.

Answer: A

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Parizeau's statement is correct. Although the OIS rate is not entirely risk-free, it is considered the best proxy for the risk-free rate to be used in valuing collateralized derivatives because the OIS rate provides a good estimate of the funding cost of collateral. LIBOR rates continue to be used for valuing non-collateralized derivatives.

86. Assume that the one-, two- and three-year LIBOR-for-fixed swaps trade at a spread of 15, 18, and 20 basis points, respectively, above the corresponding OISs. If the 10-year LIBOR-for-fixed swap rate is 4.5%, what is the best estimate for the 10-year OIS rate?

- A. 0.2%
- B. 4.3%
- C. 4.5%
- D. 4.7%

Answer: B

It is common for OISs not to trade for maturities that are as long as LIBOR-for-fixed swaps. Given a lack of reliable data for OIS maturities beyond three years in our example, a common approach is to assume that the spread (between the LIBOR swap rate and the OIS rate for the longest maturity with reliable data) remains constant for all longer maturities. As a result, all OIS rates beyond three years are assumed to be 20 basis points below LIBOR swap rates. The best estimate of the 10-year OIS rate is therefore $4.5\% - 0.2\% = 4.3\%$.



2017 FRM Part II

百题巅峰班

风险管理与投资管理

2017 年 5 月

Risk Management and Investment Management

Key Point: Factor Theory(New)

● Factors and CAPM

✧ Factors definition

- ◆ Factors are to assets what nutrients are to food.
- ◆ Factor risks are driving force behind assets' risk premiums.
- ◆ Factors matter, not assets.
- ◆ Assets are bundles of factors.
- ◆ Different investors need different risk factors.
- ◆ Factor risks are bad.
- ◆ Factor theory specifies different types of underlying factor risk.

✧ CAPM and its assumptions

◆ Assumptions:

- ✓ No transaction costs.
- ✓ assets are infinitely divisible.
- ✓ the absence of personal income tax.
- ✓ an individual can not affect the price of a stock by his trading.
- ✓ Investors' decision making solely depend on terms of returns and standard deviations of the returns.
- ✓ Unlimited short sales are allowed.
- ✓ Unlimited lending and borrowing at the riskless rate.
- ✓ All investors have identical expectations.
- ✓ All assets are marketable.

- ◆ CAPM risk premiums depend only on the assets' beta, which means only one factor – market portfolio.

- ◆ Shortcomings of CAPM come from its assumptions.

- ◆ Basic intuitions of the CAPM still holds true: risk premiums are compensation for investors' losses during bad times.

✧ Multifactor Models & SDF.

- ◆ Multifactor models define bad times over multiply factors using a pricing kernel, also known as stochastic discount factor (SDF). The SDF is denoted as m .

- ◆ m can capture all bad times by

$$m = r_f + \sum_{i=1}^k b_i f_i$$

- ◆ The SDF can be used to predict an asset's price by:

$$P_i = E[m \times \text{payoff}_i]$$

The risk premium of an asset in a relation very similar to the SML of the CAPM

$$E(r_i) - r_f = \beta_{i,m} \times \lambda_m$$

◇ Efficient Market Theory and how markets can be inefficient. Losses during bad times are compensated for by high returns.

1. Which of the following concepts most likely to be a factor?

- A. US Treasury Bill.
- B. Corporate Bonds.
- C. Private Equity.
- D. Hedge Fund.

Answer: A

Assets, including corporate bonds, private equity, and hedge funds, are not considered factors themselves, but contain many factors, such as equity risk, interest rate risk, volatility risk, and default risk.

Some assets, like equities and government bonds, can be thought of as factors themselves. Factors may also include the market (a tradable investment factor), interest rates, or investing styles (including value/growth, low volatility, or momentum).

2. Which of the following statements is a limitation of the capital asset pricing model (CAPM)?

- A. Investors have a single period investment horizon.
- B. The market is not transparent
- C. Investors have heterogeneous expectations.
- D. People need to pay a liquidity premium to do transaction.

Answer: A

The CAPM does not assume uniform taxes and transaction costs; it assumes there are no taxes or transaction costs (i.e., frictionless markets). The other limiting assumptions of the CAPM include:

- 1. Investors only have financial wealth.
- 2. Investors have mean-variance utility.
- 3. Investors have a single period investment horizon.
- 4. Investors have homogeneous (identical) expectations.
- 5. All investors are price takers.

3. Assets that have big profits during periods of low market returns have:

- A. Low betas and low risk premiums.

- B. Low betas and high risk premiums.
- C. High betas and low risk premiums.
- D. High betas and high risk premiums.

Answer: A

Assets that have losses during periods of low market returns have high betas (high sensitivity to market movements), which indicates they are risky and, therefore, should have high risk premiums. Low beta assets have positive payoffs when the market performs poorly, making them valuable to investors. As a result, investors do not require high risk premiums to hold these assets.

4. Which behavior does asset payoffs and “bad times” events would most likely perform?
- A. The expected payoff of an asset in bad times is unrelated to the asset’s expected return, because arbitrageurs eliminate any expected return potential.
 - B. The expected payoff of an asset in bad times is unrelated to the asset’s expected return, because it depends on investor preferences.
 - C. The higher the expected payoff of an asset in bad times, the higher the asset’s expected return.
 - D. The higher the expected payoff of an asset in bad times, the lower the asset’s expected return

Answer: D

The higher the expected payoff of an asset in bad times, the lower the assets expected return. Assets that have a positive payoff in bad times are valuable to hold, leading to high prices and, therefore, low expected returns.

Key Point: Factors(New)

- Factors Investing
 - ✧ Value Investing and Value Premium
 - ◆ A value-growth strategy is long value growth stocks and short growth stocks.
 - ◆ A value stock has a high book-to-market ratio, a growth stock has a low book-to-market ratio.
 - ✧ Macroeconomic risk factors
 - ◆ Economic growth, inflation, and volatility are the three most important macro factors that affect asset prices.
 - ◆ Rather than level of a factor, it is the unanticipated change to a risk factor that affects asset prices.
 - ✧ Mitigating volatility risk and Challenges
 - ◆ Two basic approaches to mitigate volatility risk:
 - ✓ Invest in less-volatile assets like bonds.
 - ✓ Buy volatility protection in the derivatives market.

✧ Dynamic risk factor

- ◆ The Fama-French model explains asset returns on three dynamic factors:
 - ✓ Traditional CAPM market risk factor.
 - ✓ A factor that captures size effect (SMB or small cap minus big cap)
 - ✓ A factor that captures value/growth effect (HML or high book-to-market value minus low book-to-market value).

✧ Value and momentum investment strategies

- ◆ A momentum strategy is long “winners” and short “losers”.
- ◆ Value strategy is a negative feedback strategy, momentum is a positive feedback strategy.
- ◆ Momentum strategies are subject to crashes.

Different strategy based on different situations and needs.

5. A high book-to-market value ratio is indicative of a:

- A. Small-cap stock.
- B. Large-cap stock.
- C. Value stock.
- D. Growth stock

Answer: C

A company's book value per share is equal to total assets minus total liabilities all divided by shares outstanding. It indicates, on a per-share basis, what a company would be worth if it liquidated its assets and paid off its liabilities. Value stocks have high book-to-market ratios while growth stocks have low book-to-market ratios.

6. Which of the following is a factor in the Fama-French three-factor model?

- A. Investment Growth.
- B. The small capitalization minus big capitalization risk factor.
- C. The winners minus losers risk factor.
- D. Inflation.

Answer: B

The Fama-French model includes the following three risk factors:

- The traditional capital asset pricing model market risk factor.
- A factor that captures the size effect (SMB).
- A factor that captures the value/growth effect (HML).

The winners minus losers (WML) momentum factor was discovered by Jagadeesh and Titman.

7. Which of the following investment strategies destabilizes asset prices most?

- A. A value strategy.

- B. A size investment strategy.
- C. A momentum investment strategy.
- D. Value, momentum, and size strategies all stabilize asset prices.

Answer: C

Value and momentum are opposite each other in that value investing is inherently stabilizing. It is a negative feedback strategy where stocks that have fallen in value eventually are priced low enough to become value investments, pushing prices back up. Momentum is inherently destabilizing. It is a positive feedback strategy where stocks that have been increasing in value are attractive to investors, so investors buy them, and prices increase even more. Momentum can be riskier than value or size investing in that it is more prone to crashes.

Key Point: Alpha and the Low-Risk Anomaly(New)

● Alpha and Low-Risk Anomaly

- ✧ Alpha, tracking error, information ratio, Sharpe ratio.
 - ◆ Alpha is the average performance of an investor in excess of their benchmark.
 - ◆ The standard deviation of excess return is known as tracking error.
 - ◆ Information ratio is the ratio of alpha to its tracking error.

$$IR = \frac{\alpha}{\sigma}$$

- ◆ If an investor is using risk free rate as benchmark, Sharpe ratio is:

$$\text{Sharpe ratio} = \frac{R_t - R_f}{\sigma}$$

- ✧ Ideal Benchmark should be:
 - ◆ Well defined.
 - ◆ Tradable.
 - ◆ Replicable
 - ◆ Adjusted for risk.
- ✧ Grinold's fundamental law of active management suggests a tradeoff between the number of investment bets placed(breadth) and the required degree of forecasting accuracy(information coefficient)

$$IR \approx IC \times \sqrt{BR}$$

- ✧ Factor Regression
 - ◆ Traditional CAPM, APT, Fama-French.
- ✧ Application of Factor Regression:
 - ◆ Style analysis
- ✧ Alphas for nonlinear strategies

✧ Risk Anomaly

◆ Risk anomaly – the stocks with low betas and low volatilities have high returns.

◆ Explanations:

- ✓ Data mining
- ✓ Leverage constraints
- ✓ Agency Problems
- ✓ Preferences

✧ A comprehensive explanation for risk anomaly is elusive.

8. Which of the following statements is incorrect concerning the low-risk anomaly?

- A. The low-risk anomaly conflicts with the CAPM.
- B. The firms with higher beta perform indifferently with the lower beta firms.
- C. The low-risk anomaly point to a negative relationship between risk and reward.
- D. The low-risk anomaly suggests that low-beta stocks will outperform high-beta stocks.

Answer: B

The low-risk anomaly violates the CAPM and suggests that low beta stocks will outperform high-beta stocks. This has been empirically proven with several studies. The CAPM points to a positive relationship between risk and reward, but the low-risk anomaly suggests an inverse relationship.

9. Which of the following statements is not true regarding benchmark?

- A. A benchmark should be well-defined.
- B. A benchmark should be replicable.
- C. A benchmark should be equally applied to all risky assets irrespective of their risk exposure.
- D. A benchmark should be tradeable.

Answer: C

An appropriate benchmark should be well-defined, replicable, tradeable, and risk-adjusted. If the benchmark is not on the same risk scale as the assets under review, then there is an unfair comparison.

10. Following Grinold's fundamental law of active management, one should find:

- A. A small number of investment bets increases the expected investment performance.
- B. To maximize the information ratio, active investors need to either have high- quality predictions.
- C. To maximize the information ratio, he shouldn't place a large number of investment bets in a given year.
- D. Investors should focus on increasing only their predictive ability relative to stock price movements.

Answer: A

Grinold's fundamental law of active management focuses on the trade-off of high quality predictions relative to placing a large number of investment bets. Investors can focus on either action to maximize their information ratio, which is a measure of risk-adjusted performance. While sector allocation is a very important component of the asset allocation decision, Grinold focused only on the quality of predictions and the number of investment bets made.

11. Why would an investor include multiple factors in a regression study?

- I. To attempt to improve the adjusted R^2 measure.
 - II. To search for a benchmark that is more representative of a portfolio's investment style.
 - III. To increase the tests of statistical significance.
- A. I only.
 - B. Both I and III.
 - C. Both I and II.
 - D. I, II, and III.

Answer: D

An investor should consider adding multiple factors to the regression analysis to potentially improve the adjusted R^2 measurement, potentially increase the tests of statistical significance, and to search for a benchmark that is more representative of a portfolio's investment style.

12. Regarding of the risk anomaly, which of the following characteristics is a possible reason?

- A. Investor preferences.
- B. The presence of highly leveraged retail investors.
- C. Lack of short selling constraints for institutional investments.
- D. Lack of tracking error constraints for institutional investments.

Answer: A

Potential explanations for the risk anomaly include: the preferences of investors, leverage constraints on retail investors that drive them to buy pre-leveraged investments in the form of high-beta stocks, and institutional investor constraints like prohibitions against short selling and tracking error tolerance bands.

Key Point: Illiquid Assets(New)

- In general, investor should be skeptical of reported returns in illiquid asset markets as they are generally overstated. There are reporting biases that result in artificially inflated returns. The three main biases that impact reported illiquid asset returns are:
 - ✧ Survivorship bias.
 - ✧ Selection Bias.
 - ✧ Infrequent trading.

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- There is little evidence that there are large illiquidity risk premiums across asset classes. However, there are large illiquidity risk premiums within asset classes. There are four primary ways that investors can harvest illiquidity premiums:
 - ✧ Allocating a portion of the portfolio to illiquid asset classes like real estate. This is passive allocation to illiquid asset classes.
 - ✧ Choosing more illiquid assets within an asset class. This means engaging in liquidity security selection.
 - ✧ Acting as a market maker for individual securities.
 - ✧ Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.
- There are several points to consider when deciding to allocate portfolio resources to illiquid assets:
 - ✧ Studies show that illiquid assets do not deliver higher risk-adjusted return.
 - ✧ Investors are subject to agency problems because one must rely on the talents and skills of portfolio managers.
 - ✧ In many firms, illiquid assets are managed separately from the rest of the portfolio.
 - ✧ Illiquid asset investors face high idiosyncratic risks.

13. When an investor has difficulty finding a counterparty that does have sufficient funds, this is known as:
- A. Agency costs.
 - B. Selection bias.
 - C. Market participation costs.
 - D. Search frictions.

Answer: D

Difficulties finding counterparty are called search frictions. For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase multimillion dollar office towers in major metropolitan areas. No matter how high the transaction costs, it may take weeks, months, or years to transact in some situations. Asymmetric information can also be a type of search friction as investors search for non-predatory counterparties with which to transact.

14. You are doing analysis on hedge funds investing, you are curious that one hedge fund who reported returns each year for the last 10 years has stopped reporting. Some of your friends told you that the fund has suffered a big loss this year. This reflects:

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- A. Infrequent trading bias.
- B. Unsmoothing returns.
- C. Sample selection bias.
- D. Survivorship bias.

Answer: D

There are no requirements for certain types of funds, like private equity funds, to report returns. As such, poorly performing funds have a tendency to stop reporting. Additionally, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called survivorship bias.

15. Which of the following variables is not an illiquidity factor that affects equity returns?

- A. On the run/off the run.
- B. Trading Frequency.
- C. Bid-ask spread.
- D. Quote size

Answer: A

There are several variables related to illiquidity that are shown to impact equity returns. They are bid-ask spreads, volume, turnover, volume measured by whether the trade was initiated by buyers or sellers, the ratio of absolute returns to dollar volume, the price impact of large trades, informed trading measures (i.e., adverse selection), quote size and depth, the frequency of trades, the number of zero returns, and return autocorrelations. On the run/off the run spread is illiquidity phenomenon you observe in U.S Treasury markets.

16. Regarding of the following strategies to harvest illiquidity premiums, which one is most likely a passive strategy?

- A. Choosing the most illiquid assets within an asset class, even if the asset class is generally considered to be liquid.
- B. Using dynamic factor strategies at the aggregate portfolio level.
- C. Acting as a market maker for individual securities.
- D. Allocating a portion of a portfolio to illiquid asset classes.

Answer: D

There are four primary ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate (i.e., this is a passive allocation to illiquid asset classes).
2. Choosing more illiquid assets within an asset class (i.e., liquidity security selection).
3. Acting as a market maker for individual securities.
4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long

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positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity risk premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.

Key Point: Portfolio Management

● Portfolio Construction Techniques

- ✧ Screens
- ✧ Stratification
- ✧ Linear Programming
- ✧ Quadratic Programming

17. Which statement about risk control in portfolio construction is correct?

- A. Quadratic programming allows for risk control through parameter estimation but generally requires many more inputs estimated from market data than other methods require.
- B. The screening technique provides superior risk control by concentrating stocks in selected sectors based on expected alpha.
- C. When using the stratification technique, risk control is implemented by overweighting the categories with lower risks and underweighting the categories with higher risk.
- D. When using the linear programming technique, risk is controlled by selecting the portfolio with the lowest level of active risk.

Answer: A

Quadratic programming requires many more inputs than other portfolio construction techniques because it entails estimating volatilities and pair-wise correlations between all assets in a portfolio. Quadratic programming is a powerful process, but given the large number of inputs it introduces the potential for noise and poor calibration given the less than perfect nature of most data.

On the other hand, the screening technique strives for risk control by including a sufficient number of stocks that meet the screening parameters and by weighting them to avoid concentrations in any particular stock. However, screening does not necessarily select stocks evenly across sectors and can ignore entire sectors or classes of stocks entirely if they do not pass the screen. Therefore, risk control in a screening process is fragmentary at best.

Stratification separates stocks into categories (for example, economic sectors) and implements risk control by ensuring that the weighting in each sector matches the benchmark weighting. Therefore, it does not allow for overweighting or underweighting specific categories.

Linear programming does not necessarily select the portfolio with the lowest level of active risk. Rather, it attempts to improve on stratification by introducing many more dimensions of risk

control and ensuring that the portfolio approximates the benchmark for all these dimensions.

18. 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

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

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

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.

19. An analyst regresses the returns of 100 stocks against the returns of a major market index. The resulting pool of 100 alphas has a residual risk of 18% and an information coefficient of 9%. If the alphas are normally distributed with a mean of 0%, roughly how many stocks have an alpha greater than 3.18% or less than -3.18%?

- A. 5
- B. 10
- C. 20
- D. 25

Answer: A

The standard deviation of the alphas = residual risk \times Information Coefficient (IC) = $0.18 \times 0.09 = 0.0162$. The alphas are normally distributed with a mean of 0, therefore there are 5% of the alphas are out of the interval. The total number of stocks is 100, so roughly there are 5 alphas that are out of the range.

Key Point: Portfolio Performance

- Performance Analysis

$$S_p = \frac{E(R_p) - R_F}{\sigma_p}$$

$$T_p = \frac{E(R_p) - R_F}{\beta_p}$$

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

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

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

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

● Performance Attribution

Refers to the set of techniques used by performance analysts to identify the sources of value addition to the portfolio. For example, how much of the performance (excess returns above benchmark) is attributable to the selection of the right asset classes or how much is attributable to selection of right sector or security within an asset class.

20. 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?

- A. 8.8 years
- B. 9.8 years
- C. 10.8 years
- D. 11.8 years

Answer: B

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

21. 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

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

22. 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	0.9500
				(t = 4.40)	(t = 12.1)
GRT	USD 500	USD 3,000	USD 3,500	0.0025	3.4500
				(t = 0.002)	(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

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.

23. 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

24. 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

25. 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

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

26. 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

Jensen's alpha is defined by:

$$\alpha_P = E(R_P) - R_F - \beta_P (E(R_M) - R_F) = 0.128 - 0.0485 - 0.7 \times 0.0525 = 4.27\%$$

27. Over the past year, the HIR Fund had a return of 7.8%, while its benchmark, the S&P 500

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index, had a return of 7.2%. Over this period, the fund's volatility was 11.3%, while the S&P index's volatility was 10.7% and the fund's TEV was 1.25%. Assume a risk-free rate of 3%. What is the information ratio for the HIR Fund and for how many years must this performance persist to be statistically significant at a 95% confidence level?

- A. 0.480 and approximately 16.7 years
- B. 0.425 and approximately 21.3 years
- C. 3.840 and approximately 0.2 years
- D. 1.200 and approximately 1.9 years

Answer: A

28. A risk manager runs a performance attribution analysis on an actively managed portfolio using a selected benchmark. The weights and performance of the different market sectors within the portfolio and the benchmark are given below:

	Benchmark		Portfolio	
Market Sector	Weight	Annual Return	Weight	Annual Return
Equity	20%	8%	40%	6%
Fixed Income	50%	4%	55%	5%
Cash	30%	2%	5%	3%

What conclusion can be drawn from the data above by using common performance attribution analysis?

- A. The portfolio outperforms the benchmark primarily because of the contribution of asset allocation.
- B. The portfolio outperforms the benchmark primarily because of the contribution of security selection within market sectors.
- C. The portfolio underperforms the benchmark primarily because of the contribution of asset allocation.
- D. The portfolio underperforms the benchmark primarily because of the contribution of security selection within market sectors.

Answer: A

Key Point: Portfolio Risk Management

● Portfolio VaR

VaR for uncorrelated positions ($\rho=0$):

$$\text{VaR}_p = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2}$$

Undiversified VaR ($\rho=1$)

$$\text{VaR}_p = \text{VaR}_1 + \text{VaR}_2$$

● Marginal VaR, Incremental VaR and Component VaR

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

$$\text{Incremental VaR}_i \approx \text{MVAR}_i \times W_i$$

$$\text{Component VaR}_i \approx \text{MVAR}_i \times W_i'$$

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

Optimal Portfolio :

$$\frac{\text{Position}_i \text{ return} - \text{risk free rate}}{\text{MVAR}_i} = \frac{\text{Position}_j \text{ return} - \text{risk free rate}}{\text{MVAR}_j}$$

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

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

● 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:

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

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.

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

Fund	Expected Return	Volatility
Alpha	5%	20%
Omega	7%	25%

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

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:

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

$$\text{Portfolio volatility} = (\text{portfolio variance})^{0.5}$$

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

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

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

30. 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:

$$\text{VAR}_p = \sqrt{(10^2 + 20^2)} = \$22.36\text{million}$$

31. 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

$$\text{VAR}_p = 1.65 \times \sqrt{(1.8 \times 0.08)^2 + (3.2 \times 0.04)^2 + 2 \times 15\% \times (1.8 \times 0.08) \times (3.2 \times 0.04)} = 0.340754$$

32. A portfolio has USD 2 million invested in Stock A and USD 1 million invested in Stock B. The 95% 1-day VaR for each individual position is USD 40,000. The correlation between the returns of Stock A and Stock B is 0.5. While rebalancing, the portfolio manager decides to sell USD 1 million of Stock A to buy USD 1 million of Stock B. Assuming that returns are normally distributed and that the rebalancing does not affect the volatility of the individual stocks, what effect will this have on the 95% 1-day portfolio VaR?
- A. There will be no effect.
 - B. It will increase by USD 20,370
 - C. It will increase by USD 21,370
 - D. It will increase by USD 22,370

Answer: D

$$\text{VaR}(\text{before}) = \sqrt{40000^2 + 40000^2 + 2 \times 0.5 \times 40000 \times 40000} = \text{USD } 69282$$

$$\text{VaR}(\text{after}) = \sqrt{20000^2 + 80000^2 + 2 \times 0.5 \times 20000 \times 80000} = \text{USD } 91652$$

So the VaR will increase by $(91,652 - 69,282) = 22,370$

33. 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?
- A. There will be no impact on the portfolio because VaR is only a prediction, and portfolio return depends on what actually happens.
 - B. The portfolio return will be lower than it should have been, given the expected risk level, because asset allocation will not have been optimal.
 - C. The risk of the portfolio will have been understated because of the incorrect estimate of correlation among global markets.
 - D. 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.

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

34. 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

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

35. Let $\beta_i = \rho\sigma_i/\sigma_p$, where ρ denotes the correlation between the return of asset i and the return of the portfolio, σ_i is the volatility of the return of asset i and σ_p is the volatility of the return of the portfolio. What is β_2 ?

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

Answer: B

Marginal $VaR_i = \beta_i \times \text{Portfolio VaR} / \text{Portfolio Value}$

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

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

36. Consider the following two asset portfolios:

Asset	Position Value (In Thousands of USD)	Return Standard Deviation (%)	Beta
A	400	3.60	0.5
B	600	8.63	1.2
Portfolio	1,000	5.92	1

Calculate the component VaR of asset A and marginal VaR of asset B, respectively, at the 95% confidence level.

- A. USD 21,773 and 0.1306

- B. USD 21,773 and 0.1169
- C. USD 19,477 and 0.1169
- D. USD 19,477 and 0.1306

Answer: C

$$\begin{aligned}\text{VaR}_p &= \alpha \times \text{portfolio standard deviation} \times \text{portfolio value} \\ &= 1.645 \times 0.0592 \times \text{USD}1,000,000 \\ &= \text{USD } 97,384\end{aligned}$$

$$\text{Component VaR}_A = \text{USD}97,384 \times 0.5 \times \frac{400}{1000} = \text{USD}19,477$$

$$\text{Marginal VaR}_B = \text{USD}97,384 \times 1.2 / \text{USD}1,000,000 = 0.1169$$

37. A risk analyst is evaluating the risks of a portfolio of stocks. Currently, the portfolio is valued at EUR 200 million and contains EUR 15 million in stock A. The standard deviation of returns of stock A is 16% annually and that of the overall portfolio is 21% annually. The correlation of returns between stock A and the portfolio is 0.37. Assuming the risk analyst uses a 1-year 99% VaR and that returns are normally distributed, how much is the component VaR of stock A?
- A. EUR 2.066 million
 - B. EUR 2.326 million
 - C. EUR 5.582 million
 - D. EUR 7.327 million

Answer: A

$$\beta = \rho \frac{\sigma_i}{\sigma_p} = 0.37 \times \frac{16\%}{21\%} = 0.2819$$

$$\text{Component VaR} = 0.2819 \times 2.326 \times 21\% \times 15 = 2.066\text{m}$$

38. 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.

39. 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: $20,000 / (0.15 \times 50,000) = 2.67$.

40. A portfolio manager wants to invest a small amount of new money that has recently come into a fund. The fund is benchmarked to an index and, rather than adding a new holding, the manager is considering increasing the holdings of one of the four assets described in the following table:

Asset	Expected Return	Beta to the Index	Beta to the Portfolio
A	12%	1.2	0.90
B	10%	0.7	0.90
C	10%	0.6	0.85
D	8%	0.3	1.10

The portfolio manager wants to select the asset that has the lowest marginal VaR as long as its Treynor ratio is at least 0.1. Assuming the risk free rate is 2%, which asset should the portfolio manager select?

- A. Asset A
- B. Asset B
- C. Asset C
- D. Asset D

Answer: C

$$TR_A = (12\% - 2\%) / 1.2 = 0.0833$$

$$TR_B = (10\% - 2\%) / 0.7 = 0.1143$$

$$TR_C = (10\% - 2\%) / 0.6 = 0.1333$$

$$TR_D = (8\% - 2\%) / 0.3 = 0.2$$

Asset B, C, D have Treynor measures greater than 0.1. Of these, C has the lowest marginal VaR as its Beta to the portfolio is the lowest.

Key Point: Surplus at Risk

Surplus (S) is the difference between the value of the assets (A) and the liabilities (L). The change in the surplus (ΔS) is equal to the change in assets (ΔA) minus the change in liabilities (ΔL). If we normalize by the assets, the return on the surplus is given by:

$$\begin{aligned} R_{\text{surplus}} &= \frac{\Delta \text{Surplus}}{\text{Assets}} = \frac{\Delta \text{Assets}}{\text{Assets}} - \left(\frac{\Delta \text{Liabilities}}{\text{Liabilities}} \right) \left(\frac{\text{Liabilities}}{\text{Assets}} \right) \\ &= R_{\text{Asset}} - R_{\text{Liabilities}} \left(\frac{\text{Liabilities}}{\text{Assets}} \right) \end{aligned}$$

Funding risk should be measured as the potential shortfall in surplus over the horizon, this is sometimes called surplus at risk.

41. On January 1, 2006, a pension fund has assets of EUR 100 billion and is fully invested in the equity market. It has EUR 85 billion in liabilities. During 2006, the equity market declined by 15% and yields increases by 1.2%. If the modified duration of the liabilities is 12.5, what is the pension fund's surplus on December 31, 2006?

- A. EUR 15.00 billion
- B. EUR 12.93 billion
- C. EUR 12.75 billion
- D. EUR 12.57 billion

Answer: C

The surplus at the beginning of the year was $100 - 85 = 15$ billion EUR. During the year, the equity portfolio declines 15%, or 15 billion EUR, to 85 billion EUR. Due to the increase in yields, the dollar value of the liabilities decrease by $12.5 \times 1.2\% \times 85$ billion EUR, or 12.75. Thus at the end of the year, the assets are worth $(100 - 15) = 85$ billion EUR and the liabilities $(85 - 12.75) = 72.25$ billion. The surplus is the 12.75, a decrease of 2.25 billion EUR.

42. 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

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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

Expected surplus growth = $(\$165\text{m} \times 0.078) - (\$150\text{m} \times 0.045)$

Expected surplus growth = $\$12.87\text{m} - \$6.75\text{m} = \$6.12\text{m}$

Variance of surplus = 355.104, Standard Deviation = 18.84m

Surplus at risk = expected growth in surplus – $1.65 \times$ Standard Deviation of Surplus

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

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

43. At the end of 2007, Chad & Co.'s pension had USD 350 million worth of assets that were fully invested in equities and USD 180 million in fixed-income liabilities with a modified duration of 14. In 2008, the wide spread effects of the subprime crisis hit the pension fund, causing its investment in equities to loss 50% of their market value. In addition, the immediate response from the government – cutting interest rates – to salvage the situation, caused bond yields to decline by 2%. What was the change in the pension fund's surplus in 2008?

- A. USD -55.4 million
- B. USD -124.6 million
- C. USD -225.4 million
- D. USD -230.4 million

Answer: C

The change in the pension fund's surplus for the year 2008 is equal to the initial surplus S_0 at the end of 2007 less the ending surplus S_1 at the end of 2008.

The initial surplus is calculated as $S_0 = 350 - 180 = 170$.

Next we have to calculate the surplus at the end of 2008. Given the 50% decline in the equity market, the new level of assets A_1 at the end of 2008 is equal to:

$$(1 - 0.5) \times 350 = 175$$

The new level of liabilities L_1 can be calculated as:

$$L_1 = (1 - 14 \times (-0.02)) \times 180 = 230.4$$

Therefore the 2008 surplus S_1 is equal to $A_1 - L_1 = 175 - 230.4 = -55.4$ (which implies the pension

fund is actually in a deficit situation at the end of 2008). The change in surplus for 2008 is hence $S_1 - S_0 = -55.4 - 170 = -225.4$ million.

44. At the end of 2014, a pension fund had USD 650 million worth of assets that were fully invested in equities and USD 320 million in fixed-income liabilities with a modified duration of 13. In 2015, the widespread effects of the global energy crisis hit the pension fund, causing its investment in equities to lose 40% of their market value. In addition, the immediate response from the government — cutting interest rates — to salvage the situation, caused bond yields to decline by 1.8%. What was the change in the pension fund's surplus in 2015?
- A. USD -330.00 million
 B. USD -245.12 million
 C. USD-185.12 million
 D. USD -144.88 million

Answer: C

Explanation: The change in the pension fund's surplus (ΔS) for the year 2015 is equal to the ending surplus (S_1) at the end of 2015 less the initial surplus (S_0) at the end of 2014. That is, $\Delta S = S_1 - S_0$. The initial surplus is calculated as $S_0 = A_0 - L_0 = 650 - 320 = \text{USD } 330$ million, where A_0 = the firm's initial assets and L_0 = the firm's initial liabilities. Next we have to calculate S_1 , the surplus at the end of 2015. Given the 40% decline in the equity market, the new level of assets A_1 at the end of 2015 is equal to: $A_1 = (1 - 0.4) * 650 = \text{USD } 390$ million.

Since the percentage change in liability value = $-DM * \Delta y$, where DM = modified duration = 13; and Δy = change in yield = -1.8% , then the new level of liabilities L_1 at the end of 2015 can be calculated as: $L_1 = [1 - (DM * \Delta y)] * L_0 = (1 - 13 * 0.018) * 320 = \text{USD } 245.12$ million. Thus, the ending surplus for 2015 = $S_1 = A_1 - L_1 = 390 - 245.12 = \text{USD } 144.88$ million. Therefore the change in surplus for 2015 = $\Delta S = S_1 - S_0 = 144.88 - 330 = \text{USD } -185.12$ million (which implies the pension fund is actually in a deficit situation at the end of 2015).

45. An analyst reports the following fund information to the advisor of a pension fund that currently invests in government and corporate bonds and carries a surplus of USD 10 million

Pension Assets	Pension	Liabilities
Amount (in USD million)	100	90
Expected Annual Growth	6%	7%
Modified Duration	12	10
Annual Volatility of Growth	10%	5%

To evaluate the sufficiency of the fund's surplus, the advisor estimates the possible surplus values at the end of one year. The advisor assumes that annual returns on assets and the

annual growth of the liabilities are jointly normally distributed and their correlation coefficient is 0.8. The advisor can report that, with a confidence level of 95%, the surplus value will be greater than or equal to:

- A. USD -11.4 million
- B. USD -8.3 million
- C. USD -1.7 million
- D. USD 0 million

Answer: C

The lower bound of the 95% confidence interval is equal to: Expected Surplus – (95% confidence factor × Volatility of Surplus). The required variables can be calculated as follows:

$$\text{Variance of the surplus} = 100^2 \times 10\%^2 + 90^2 \times 5\%^2 - 2 \times 100 \times 90 \times 10\% \times 5\% \times 0.8 = 48.25$$

$$\text{Volatility of the surplus} = 6.94$$

$$\text{The expected surplus} = 9.7$$

$$\text{Therefore, the lower bound of the 95\% confidence interval} = 9.7 - 1.645 \times 6.94 = -1.725$$

46. Which of the following statements about risk management in the pension fund industry is correct?

- A. A pension plan's total VaR is equal to the sum of its policy-mix VaR and active management VaR.
- B. Pension fund risk analysis does not consider performance relative to a benchmark.
- C. In most defined-benefit pension plans, if liabilities exceed assets, the shortfall does not create a risk for the plan sponsor.
- D. From the plan sponsor's perspective, nominal pension obligations are similar to a short position in a bond.

Answer: D

Explanation: Liabilities at a pension fund are typically composed of accumulated benefit obligations, measured by the present value of all pension benefits owed to employees discounted by an approximate interest rate. When liabilities consist mostly of nominal payments, their value in general will behave like a short position in a long-term bond.

47. A company's pension fund is established as a defined benefit plan, and therefore the board must consider funding risk. Which of the following statements about the pension fund's funding risk is correct?

- A. The longer the horizon for expected payouts, the lower the funding risk.
- B. Decreases in interest rates will reduce funding risk.
- C. The funding risk has been effectively transferred to the employees.

D. Funding risk represents the true long-term risk to the plan sponsor.

Answer: D

Explanation: The time horizon of payouts does not eliminate funding risk. In fact it is the mismatch between assets and liabilities that creates funding risk. In an low interest rate environment the value of equities will rise, however the value of the liabilities are likely to increase more thereby exacerbating funding risk. Funding risk is transferred to employees with a defined contribution plan. Immunizing the portfolio, essentially matching duration of assets and liabilities, will reduce funding risk.

Key Point: Hedge Fund Trading Strategy

- Equity long/short strategy: go long and short similar securities to exploit mispricing-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.

48. What critical shift occurred in the hedge fund industry following the collapse of LTCM in 1998 and the dot-com bubble burst in 2001?

- A. There was a significant drop in assets under management in the hedge fund industry.
- B. There was a large influx of institutional investors investing in hedge funds.
- C. Reporting within the hedge fund industry became more regulated than mutual funds.
- D. There was a significant increase in hedge fund failures.

Answer: B

49. Which of the following statements about convertible arbitrage hedge fund strategies is

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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

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.

50. 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.

51. 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.

52. A fund of hedge funds combines a mix of strategy sectors, managers, and styles, and therefore fund of funds risk managers need to understand the common attributes of hedge fund strategies. Which of the following statements is incorrect?
- A. Equity market neutral funds aim to generate returns that have low correlation with the overall equity market and to insulate their portfolios from broad market risk factors.
 - B. Convertible arbitrage funds typically purchase securities that are convertible into the issuer's stock and simultaneously short the underlying stock. These funds earn returns in part from gamma trading on the stock's volatility.
 - C. Merger arbitrage funds buy the stock of an acquisition target company and simultaneously short the bidding company's stock. These funds have large exposure to deal risk.
 - D. Equity short-selling funds sell stocks not currently owned by the seller in order to take a directional bet that the stock price will decline. These funds tend to be uncorrelated with traditional long-only equity portfolios.

Answer: D

53. An acquisition has been announced by Company A to merge with Target Company T. Before the announcement, acquirer A's shares traded at \$21 and Target T's shares traded at \$6 price. The proposed share-for-share exchange ratio was 1:2. Subsequent to the announcement, Acquirer A's shares trade down to \$20 and Target T's shares trade up to \$8. At this time, a merger arbitrage hedge fund takes a short position in Acquirer's A's stock hedged by a long position in Target T's stock. The merger is successful and the prices close at \$28 (Acquirer) and \$14 (Target). What is the gain per each single shorted share of Acquirer A?
- A. Zero per share of Acquirer A
 - B. -\$2 loss per share of Acquirer A
 - C. +\$1 gain per share of Acquirer A
 - D. +\$4 gain per share of Acquirer A

Answer: D

The merger arbitrage is long 2.0 shares of Target T, at \$8.00 per share, for each short 1.0 share of

Acquirer A, at \$20.00 share.

The net gain = $2.0 \times (\$14 - \$8) - 1.0 \times (\$28 - \$20) = \$12 - \$8 = +\$4$ per share of Target T.

Any 2:1 price outcome will produce a +\$4 per (Target T's) share gain; e.g., \$30/15, \$32/\$16.

54. How would the risk in a merger arbitrage strategy best be characterized?
- The arbitrage can be structured so there is a gain no matter the outcome.
 - The arbitrageur's loss if the deal does not go through is much greater than the gain if the deal goes through.
 - The arbitrage can be structured as riskless, assuming no other bidders come forward after the initial offer.
 - The arbitrageur's gain on the deal if it does go through is much greater than the loss if the deal does not go through.

Answer: B

Typically, the arbitrage is to go long in the target's stock and short the acquirer's stock. The arbitrage is not really a hedge protecting a loss if the deal does not go through. The target stock could fall below pre-announcement price, and the acquirer stock could substantially increase.

55. The Big Bucks Hedge fund has the following description of its activities. It uses simultaneous long and short positions in equity with a net beta close to zero. Which of the following statements about Big Bucks are correct?
- It uses a directional strategy.
 - It is a relative value hedge fund.
 - This fund is exposed to idiosyncratic risks.
- I and II
 - II and III
 - I and III
 - II only

Answer: B

Key Point: Hedge Fund Risk

- Liquidity Risk
 - ✧ More liquid assets should exhibit less serial autocorrelation than illiquid assets.
 - ✧ A Q-statistic is used as a summary measure of the overall statistical significance of autocorrelations.
 - ✧ This create two biases: Low correlations; Low volatility
- Style Drift

- ◇ Changes in the risk factor exposures
- ◇ Changes in the overall risk of the fund

● Phase-Locking Phenomenon

56. 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.

57. A factor analysis of returns for hedge funds employing a equity market-neutral strategy produces strongly positive performance information for the strategy (for example, impressive Sharpe ratios). However, the analysis is guilty of neglecting the effects of survivorship bias. If the problem is survivorship bias, which of the following criticisms of the methodology is best?
- A. The sample is too small
 - B. The historical window is too short
 - C. Risk metrics needs to be included along with return metrics
 - D. Past performance is no guarantee of future performance

Answer: A

The sample is too small: survivorship bias implies that certain non-performing funds (e.g., funds that went out of business) are not included in the sample, it is an issue of the sample.

Answer (D) is closely related and answer (D) is probably true, but (D) relates to interpretation and (A) is more directly the implied methodological flaw. So, (D) is fine, but (A) is a little better.

58. A risk analyst at an investment bank is reviewing the way performance analysis of hedge funds and real estate funds have been conducted. Each year, whenever a hedge fund stops trading, the hedge fund is removed from the database of hedge funds. Also, because of the addition of new assets to the real estate fund, the liquidity of that asset category has improved

each year and trading has become more frequent. Which of the following best describes the impacts these changes have historically had on hedge fund and real estate fund analyses performed using these databases?

- A. The average Sharpe ratio of hedge funds is understated and the average Sharpe ratio of real estate funds has increased.
- B. The average Sharpe ratio of hedge funds is overstated and the average Sharpe ratio of real estate funds has decreased.
- C. The average volatility of hedge funds is overstated and the average volatility of real estate funds has decreased.
- D. The average volatility of hedge funds is understated and the average volatility of real estate funds has increased.

Answer: A

As poor performers drop out of the database, the average performance increases. The removal of poor performers could actually reduce average volatility and the correlation of returns. The Sharpe Ratio tends to get inflated due to survivorship bias. With infrequent trading, estimates of volatilities, correlations, and betas are too low when computed using reported returns. Thus, Sharpe ratios would be higher under the circumstances. When trading becomes more frequent, the Sharpe ratios will be lower in – due to higher volatilities – in comparison with those under infrequent trading condition.

59. 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.

60. For a portfolio of illiquid assets, hedge fund managers often have considerable discretion in portfolio valuation at the end of each month and may have incentives to smooth returns by marking values below actual in high-return months and above actual in low-return months. Which of the following is not a consequence of return smoothing over time?

- A. Higher Sharpe ratio
- B. Lower volatility
- C. Higher serial correlation
- D. Higher market beta

Answer: D

61. 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.

62. In performing due diligence on a potential investment manager, which of the following factors is the least important for the investor to consider?

- A. Risk controls
- B. Business model
- C. Past performance
- D. Investment process

Answer: C

Investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not be unduly concerned with a manager's past successes given that past performance is not always indicative of future performance. Risk controls, the business model, and the investment process are all fundamental parts of the due diligence process.

63. A due diligence specialist is evaluating the risk management process of a hedge fund in which his company is considering making an investment. Which of the following statements best describes criteria used for such an evaluation?

- A. Because of the overwhelming importance of tail risk, the company should not invest in the fund unless it fully accounts for fat tail using extreme value theory at the 99.99% level when estimating VaR.
- B. Today's best practices in risk management require that a fund employ independent risk service providers and that these service providers play important roles in risk-related decisions.
- C. When considering a leveraged fund, the specialist should assess how the fund estimates risks related to leverage, including funding liquidity risks during periods of market stress.
- D. It is crucial to assess the fund's valuation policy, and in general if more than 10% of asset prices are based on model prices or broker quotes, the specialist should recommend against investment in the fund regardless of other information available

about the fund.

Answer: C

Generally speaking, with a leveraged fund, an investor will need to evaluate historical and current changes in leverage, as well as the level of liquidity of the portfolio, particularly during times of market stress. Certain strategies may in fact expose an investor to tail risk, so while an investor should inquire whether the manager believes that tail risk exists, and whether or not it is hedged, it is then up to the investor to decide whether to accept the risk unhedged or hedge it on their own. Many funds employ independent risk service providers to report risks to investors, but these firms do not get involved in risk related decision making. And finally, while it is important to know what percentage of the assets is exchange-traded and marked to market, what might be acceptable may differ depending on the strategy of the fund.



2017 FRM Part II

百题巅峰班

当前金融市场风险案例

2017 年 5 月

Key Point: Bitcoin: Economics, Technology, and Governance

- Bitcoin is an online communication protocol that facilitates the use of a virtual currency, including electronic payments. Virtual currencies like bitcoin, by design include mechanisms like:
 - ✧ excluding the need for a central authority to issue or distribute coins
 - ✧ public verification of transaction records
 - ✧ rewarding of honest participation
 - ✧ facilitating anyone to create an account, without charge
 - ✧ no obligation to verify user identity
 - ✧ imposing no prohibition on sales of particular items
- Built-in Incentives
 - ✧ Every new transaction that takes place on the Bitcoin network is periodically grouped together in a “block” of recent transactions.
 - ✧ To make sure no unauthorized transactions have been inserted, the block itself is compared to the most recently published block, thus yielding a linked sequence of blocks, or “block chain.”
 - ✧ With this data structure in place, any Bitcoin user can verify that a prior transaction did in fact occur. In principle, a system like Bitcoin could validate transactions using a simple consensus by majority vote, with a majority of connected users able to affirm that a given transaction in fact occurred.
 - ✧ This process is called “mining” and recursively ensures that the total historical ordering on all blocks (“chain”) is agreed by the entire network. The miners who verify the block chain are rewarded with bitcoins.
- Some shortcomings that remain inherent to the Bitcoin system are:
 - ✧ While the Bitcoin protocol supports complete decentralization, significant economic forces push towards de facto centralization and concentration among a small number of intermediaries at various levels of the Bitcoin ecosystem.
 - ✧ Significant privacy concerns still remain because transactions can be linked back to the people who made them. Bitcoin transactions are not truly anonymous.
 - ✧ Imposing no prohibition on sales of particular items means unlawful transactions could take place in the absence of regulators.
 - ✧ Bitcoin payments are irreversible providing no way for a payer to reverse an accidental or unwanted purchase.
- Bitcoin’s design presents distinctive risks that differ from other payment methods and stores of value.
 - ✧ Market risk: Any user holding bitcoins faces market risk via fluctuation in the exchange rate between bitcoin and other currencies.

- ✧ Counterparty risk
- ✧ Transaction risk: The irreversibility of Bitcoin payments creates heightened transaction risk.
- ✧ Operational risk:
- ✧ Privacy risks: Bitcoin raises certain privacy risks, most notably the risk that transactions can be linked back to the people who made them.
- ✧ Legal and regulatory risks: Bitcoin systems face numerous legal and regulatory risks across countries.
- Bitcoin receives regulatory scrutiny for three classes of criminal concerns:
 - ✧ Bitcoin-specific crimes
 - ✧ Money laundering
 - ✧ Bitcoin-facilitated crime
- The need for consumer protection also justifies for regulatory action in virtual currencies.
- Bitcoin may be able to accommodate a community of experimentation built on its foundations. Mixers already close the most obvious privacy shortcomings in Bitcoin's early design, while pools help reduce risk for miners, and wallets address some of consumers' usability and security concerns.
- ✧ Other aspects of Bitcoin architecture are largely locked in place through its protocol design.

1. Which of the following statements is/are correct regarding the incentives to use a virtual currency?
 - I. Bitcoin is a virtual currency that transacts using blockchain technology.
 - II. The Bitcoin verification process utilizes a key system similar to HTTPS protocols.
 - III. Fees paid to Bitcoin miners are the primary incentive for honesty in the blockchain infrastructure.
 - IV. The incentive for honesty in Bitcoin transactions is a structured regulatory system.
 - A. I and II
 - B. II and IV
 - C. III and IV
 - D. I, II, and III

Answer: D

Bitcoin is a virtual currency that transacts utilizing blockchain technology. It deploys a system of private and public keys just like the HTTPS protocol. The fees paid to Bitcoin miners are the only formal incentive to encourage honesty in the verification process because there is not a centralized regulatory structure supervising Bitcoin transactions.

2. Which of the following statements about Bitcoin centralization structures is correct?

- A. Mining pools were not created to solve the problem of miners conducting work with a low probability of payoff.
- B. Mixers blur transaction audit trails.
- C. Digital wallet services are a safe way to transact in Bitcoins.
- D. Mixers are not designed to protect anonymity in Bitcoin transfers.

Answer: B

Mining pools were designed to allow syndicates of miners to jointly profit if one of the miners in the group successfully validates a transaction. This helps alleviate the problem of miners using tremendous effort to find the public key to validate a transaction and then miss the payment because another miner conducted the hunt faster. Digital wallets are a step forward in organization, but they may present risk to the Bitcoin owner. If the digital wallet is hacked, then Bitcoins can be stolen unless the owner retains the private key, in which case it is still subject to data security risks. Mixers do blur the audit trail, and for this reason, they help to protect anonymity in the blockchain transaction storage system.

3. Which of the following items is/are a risk borne by the Bitcoin structure?
- I. The irreversibility of transactions subtracts a layer of protection afforded to traditional payment methods.
 - II. Bitcoins do not face counterparty risk because all transactions are anonymous.
 - III. Low trading volume in the Bitcoin currency adds another layer of market risk to those who want to own the currency.
 - IV. Blockchain transactions may not be anonymous if the user makes certain types of transactions.
- A. I and II
 - B. II and IV
 - C. I, III and IV
 - D. I, II, III and IV

Answer: C

Bitcoins do face counterparty risk because some wallet services are hacked and some currency exchanges shut down. The irreversibility of Bitcoin transactions is a key risk for patrons. It makes accidental transactions an issue. The shallow market for Bitcoins does compound currency volatility. Blockchain transactions may sacrifice their anonymous features if the user ships products to a physical address or transacts on a monitored currency exchange.

4. Which of the following items are not correct with respect to the regulation of Bitcoin?
- I. Bitcoins need to be regulated because of money laundering and several categories of illegal transactions.

4-20

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- II. Theft of Bitcoin can be easily tracked to the specifically identifiable party that stole the Bitcoin.
- A. I only.
- B. II only.
- C. Both I and II.
- D. Neither I nor II.

Answer: B

Bitcoins have been shown to be used for money laundering and various other illegal activities. However, regulation of Bitcoins is challenging due to the semi-anonymous nature of the accounts and the global reach of this virtual currency. All global jurisdictions will need to come to a common regulatory understanding, or users will be able to exploit regulatory arbitrage. Theft of Bitcoins is easily tracked to the account that stole them. This is accomplished using the blockchain structure, but this structure also makes it very difficult to find out who owns a given account unless they make a mistake that reveals their identity.

Key Point: Market and Funding Liquidity—An Overview

- The two distinct types of liquidity are market liquidity and funding liquidity.
- Although market and funding liquidity are often treated as distinct, they can be closely related, specially during a financial crisis.
 - ✧ If funding liquidity declines because of market stress, for example, this may cause intermediaries to become less willing to provide market liquidity.
 - ✧ Declines in market liquidity, in turn, may further impair funding liquidity, creating a negative feedback dynamic.
- Factors affecting liquidity
 - ✧ Changes in regulatory requirements undoubtedly affect liquidity, while other non-regulatory factors are also important factors affecting liquidity.
 - ✧ Liquidity provision is affected by changes in market structure, how trades are executed, and by competition from those operating outside of the regulatory boundaries that have been established for systemically-important financial institutions.
 - ✧ Similarly, the demand for liquidity is also evolving with the growth of large asset managers, mutual funds, exchange traded funds (ETFs) and principal trading firms (PTFs) – which are sometimes referred to as high-frequency trading firms.
- Regulatory factors affecting market liquidity
 - ✧ The evidence for market liquidity having diminished in the recent years due to increase in regulator burden is mixed. While the available evidence suggests that the changes in the regulatory regime are likely important, considerably more work needs to be done in this area

before a definitive conclusion is reached on their relative contribution.

- ✧ In contrast to the market liquidity metrics such as bid-ask spreads, indirect evidence on market liquidity suggests that there has been a decline.
- Non-regulatory factors affecting market liquidity
- ✧ Liquidity provision is affected by: changes in market structure; how trades are executed; competition from those operating outside of the regulatory boundaries that have been established for systemically-important financial institutions.
- ✧ The demand for liquidity is also evolving with the growth of large asset managers, mutual funds, exchange traded funds (ETFs) and principal trading firms (PTFs) – which are sometimes referred to as high-frequency trading firms.
- While funding liquidity is distinct in its own way, it does have a direct link back to market liquidity.
- All else equal, stronger capital requirements reduce firms' vulnerability to runs. This suggests that funding liquidity risk can be addressed in many different ways.
- ✧ First, capital requirements can be bolstered to reduce the risk that a firm will become insolvent in particularly bad states of the world.
- ✧ Second, improved reporting and transparency can reduce the degree of uncertainty about whether a firm is solvent, thus reducing the risk that investors might wrongly perceive that a firm is insolvent, when, in fact, it still has adequate capital.
- ✧ Third, liquidity requirements can be increased to reduce the risk that the firm will have to engage in a fire sale of assets that might deplete its capital. A liquidity buffer gives the firm's management time to respond to bad events without having to resort immediately to selling assets.
- ✧ Fourth, a lender-of-last-resort can provide a liquidity backstop that makes funding liquidity more resilient.

5. Which of the following reasons would likely suggest that market liquidity has decreased in recent years?

- A. Larger trades occurring with larger price changes.
- B. Stable quoted bid-ask spreads (U.S. Treasuries)
- C. Order book depth that is not unusually low (U.S. Treasuries)
- D. Falling realized bid-ask spreads for corporate bonds.

Answer: A

Evidence to suggest that market liquidity has not decreased includes: (1) stable quoted bid-ask spreads (U.S. Treasuries), (2) order book depth that is not unusually low (U.S. Treasuries), and (3) falling realized bid-ask spreads for corporate bonds.

Evidence to suggest that market liquidity has decreased includes: (1) larger trades now tend to result in large securities price changes, (2) average trade sizes have fallen, and (3) increased bifurcation in corporate bond markets (i.e., liquidity is biased in favour of larger and more recent bond issuances by larger issuers).

6. Which of the following factors has had the greatest impact on the liquidity of U.S. Treasuries?

- I The Volcker Rule.
 - II Supplementary leverage ratio (SLR).
 - III Basel risk-weighted capital ratio.
 - IV Comprehensive Capital and Analysis Review (CCAR) stress tests.
- A. I and II
 - B. II and IV
 - C. III and IV
 - D. I, III and IV

Answer: D

For U.S. Treasuries, the key change is the supplementary leverage ratio (SLR) that caps the amount of leverage permitted by dealers. In computing the SLR, the same amount of regulatory capital is required on all assets, regardless of their risk levels. Accordingly, there is now much less financing of low-risk assets, such as repos.

For corporate bonds, there have been three key changes: (1) the increase in the Basel risk-weighted capital ratio, (2) the Comprehensive Capital and Analysis Review (CCAR) stress tests, and (3) the Volcker Rule.

7. Which of the following factors is considered a regulatory factor impacting liquidity?

- A. High-frequency trading
- B. Monetary policy.
- C. Supplementary leverage ratio (SLR).
- D. Basel risk-weighted capital ratio.

Answer: D

Changes in monetary policy would be an example of a non-regulatory factor impacting liquidity.

There are three regulatory factors that have impacted liquidity: (1) the increase in the Basel risk-weighted capital ratio, (2) the Comprehensive Capital and Analysis Review (CCAR) stress tests, and (3) the Volcker Rule.

8. Which of the following statements regarding the link between market and funding liquidity is correct?

- A. The fixed-rate on an interest rate swap should always be lower than the yield on a Treasury note of the same term.
- B. A narrower dispersion of Treasury yields compared to a fitted Treasury yield curve is indicative of lower funding liquidity.
- C. A lack of market liquidity results in fewer arbitrage opportunities available.
- D. The correlation between the levels of funding liquidity and market liquidity tends to raise during times of market crisis.

Answer: D

The fixed rate on an interest rate swap of a given term should be higher than the yield on a Treasury note of the same term due to the greater risk of the swap.

A lack of market liquidity will result in lower price efficiency with a greater number of arbitrage opportunities. A higher level of correlation between funding liquidity (e.g., the fall in the amount of dealer-funded repos backed by U.S. Treasuries and wider dispersion of Treasury yields compared to a fitted Treasury yield curve) and market liquidity (e.g., rise in Treasury bid-ask spreads) exists during times of market crisis. A narrower (wider) dispersion of Treasury yields compared to a fitted Treasury yield curve is indicative of higher (lower) funding liquidity.

9. Which of the following methods is not the most appropriate way to reduce funding liquidity risk?
- A. Performing more Stress tests.
 - B. Imposing higher liquidity requirements.
 - C. Maintaining stable capital requirements.
 - D. Using a central bank as the lender-of-last-resort.

Answer: C

Funding liquidity risk can be reduced by having a lender-of-last resort to provide a source of liquidity to strengthen funding liquidity. In practice, a central bank (e.g. Federal Reserve) may be able to function as the lender-of-last-resort to improve the confidence that counterparties have with each other and, thereby, increase market and funding liquidity.

Stress tests should be performed to allow for a more accurate assessment of a firm's solvency. Higher liquidity requirements, such as the liquidity coverage ratio, should be imposed to reduce funding liquidity risk. It is not sufficient to just maintain stable capital requirements; stronger capital requirements are needed to minimize the risk of insolvency during tougher economic times.

Key Point: Market Liquidity—Resilient or Fleeting?

- Some of the factors and their effects on liquidity levels and resilience

- ✧ Market Structure: Only some markets show obvious signs of worsening market liquidity.
- ✧ Cyclical conditions: Cyclical factors are among the most important drivers of liquidity, and changes in them can help predict shifts in liquidity regimes.
- ✧ Regulation: Regulatory changes is seen to have had mixed effects on market liquidity.
- ✧ Investor base: Changes in investor base have likely increased liquidity risk.
- ✧ Monetary policy: Monetary policy has had a positive impact on market liquidity in recent years but may have increased liquidity risk.
- The drivers of market liquidity levels and resilience fall into three broad categories.
- ✧ The risk appetite, funding constraints, and market risks faced by financial intermediaries, all of which affect their inclination to provide liquidity services and correct the mispricing of assets by taking advantage of arbitrage opportunities.
- ✧ Search costs, which influence the speed with which buyers and sellers can find each other.
- ✧ Investor characteristics and behavior reflecting different mandates, constraints, and access to information.
- The monetary policy measures included:
 - ✧ Asset purchases, or so-called quantitative easing (QE) measures
 - ✧ The expansion in the availability of central bank liquidity to the financial sector through specific facilities.
 - ✧ Various facilities included changes to eligible collateral against which the central bank would extend credit.
- Traditional monetary policy expansions affect market liquidity by reducing the costs of market making and trading. The reduction in market-making costs may be greater if overall uncertainty is reduced.
- The unconventional monetary policy measures taken by central banks after the global financial crisis have had additional effects on market liquidity.
- Market illiquidity and the associated financial stress can spill over to other asset classes.
- On market microstructure design:
 - ✧ Reforming the design of markets should be encouraged. Objectives would include creating incentives for instrument standardization, designing circuit breakers based on liquidity conditions rather than prices, and enhancing transparency.
 - ✧ Open access to electronic platforms should become the norm. The analysis of the introduction of electronic platform trading of OTC derivatives underscores the importance of product standardization and of equal access to trading venues to allow buy-side firms to act as alternative market makers. However, the introduction of electronic platforms can attract new players, such as high-frequency trading firms, to the market, whose impact still needs to be further understood.

- ✧ Restrictions on the use of financial derivatives should be reevaluated. The analysis of the after-effects of the EU ban on uncovered CDS confirms the view that regulations on derivatives can distort markets and reduce liquidity in the associated cash market.
- On the role of central banks:
 - ✧ Central banks should take into account the effects on market liquidity when making policy. For example, to counteract the potential scarcity created by large-scale asset purchases, central banks could set up securities-lending facilities.
 - ✧ Central banks and financial supervisors should routinely monitor market liquidity in real time across several asset classes, but especially in the investment-grade bond market. They should use a wide range of market liquidity measures with an emphasis on metrics derived from transactions-level data.
 - ✧ In periods of financial market stress, central banks could use various instruments, including their collateral policies, to enhance market liquidity. In particular, they can do so by accepting, with appropriate haircuts, a wide range of assets as collateral for repo transactions.
- On the regulation and supervision of financial intermediaries:
 - ✧ Liquidity stress testing for banks and investment funds should be conducted taking into account the systemic effects of market illiquidity.
 - ✧ Liquidity mismatches in the asset management industry should be mitigated.
- The five main policy recommendations can be summarized as:
 - ✧ 1. During normal times, policymakers should ensure through preventive policies that liquidity is resilient. Moreover, they need to monitor liquidity developments with a policy strategy in hand to deal with episodes of market illiquidity.
 - ✧ 2. Market infrastructure reforms (equal-access electronic trading platforms, standardization) should continue with the goal of creating more transparent and open capital markets.
 - ✧ 3. Trading restrictions on derivatives should be reevaluated.
 - ✧ 4. In the process of normalization of monetary policy in the United States, good communication and attention to liquidity developments across markets will be important to avoid disruptions in market liquidity in both advanced and emerging market economies. Central banks should take market liquidity into account when conducting monetary policy.
 - ✧ 5. Regulators should develop measures to reduce liquidity mismatches and the first-mover advantage at mutual funds.

10. Which of the following measures accurately describes how liquidity can be measured in a given market?

- A. Turnover is used to compare price changes for a given trading volume.
- B. Dealer count looks at market breadth based on market participants and implied liquidity.

- C. Roll's price reversal is used to measure the difference between median and actual prices.
- D. Dealer count looks at market depth by showing how many dealer quotes exist on a given security.

Answer: D

Turnover measures trading activity by looking at trading volume and market values. Dealer count looks at market depth by showing how many dealer quotes exist on a given security. Roll's price reversal measures bid-ask spreads using covariances between price changes.

11. Which of the following statements is least accurate in regard to liquidity drivers during the 2013 taper tantrum?
- A. Smaller and riskier bonds were less liquid than larger-scale, lower-risk bonds.
 - B. Greater concentrations of investment company holdings help to maintain liquidity.
 - C. There is a positive relationship between the number of market makers and overall liquidity.
 - D. Bonds that had greater pretrade transparency outperformed bonds with less transparency from a liquidity standpoint.

Answer: B

Based on the number of quotes, bonds that had greater pretrade transparency outperformed bonds with less transparency from a liquidity standpoint. Smaller and riskier bonds were less liquid than larger-scale, lower-risk bonds. Greater concentrations of investment company holdings reduced liquidity. There is a direct (positive) relationship between the number of market makers and overall liquidity.

12. Which of the following effects resulting from monetary policy decisions has been most beneficial to liquidity?
- A. Expanding the range of assets eligible for repo transactions.
 - B. Decreases in risk appetite by market makers.
 - C. Large-scale asset purchases by central banks.
 - D. European Union (EU) restrictions on sovereign credit default swaps.

Answer: A

Expanding the range of assets eligible for repo transactions would increase liquidity. When market makers have increased risk appetites, this leads to increased inventories and overall trading, which has a positive impact on market liquidity. Large-scale asset purchases have been both positive (due to the central bank's role as a dependable buyer) and negative (purchases of these assets may make them scarce). EU restrictions on sovereign credit default swaps have harmed overall liquidity in the European sovereign bond market.

13. All of the following statements regarding liquidity spillovers are correct except:

- A. A liquidity shock that originates in the investment-grade bond market will likely have a greater impact on the high-yield bond market.
- B. Spillovers have a lower impact when the economy is experiencing a high level of financial stress.
- C. In the years following the most recent financial crisis, spillovers have exhibited greater levels of volatility.
- D. A liquidity spillover will likely have a greater impact on assets that are correlated versus those that are uncorrelated.

Answer: B

Spillovers have a greater impact when the economy is experiencing a high level of financial stress.. All of the other statements are accurate.

Key Point: Algorithmic Trading Briefing Note

- four key risks associated with algorithmic trading
 - ✧ Systemic risks may be amplified
 - ✧ Significant intraday risks faced without transparency and robust controls
 - ✧ Internal controls may not have kept pace with speed and market complexity.
 - ✧ Without adequate controls, losses can accumulate and spread rapidly.
 - ✧ Sound practices
 - ✧ Controls must keep pace with technological complexity and trading speeds.
 - ✧ Governance and management oversight can limit exposure to losses and improve transparency.
 - ✧ Testing needs to be conducted during all phases of a trading product's lifecycle, namely during development, rollout to production, and ongoing maintenance.
 - ✧ When assessing control depth and suitability, management should ensure sufficient involvement of control functions as well as business-unit management.
 - ✧ Questions for firms and supervisors
 - ✧ Business-Unit/Desk-Management Level
 - ✧ Control-Function and Senior-Management Level
 - ✧ Board and Executive Level
- There are tools and controls to monitor the risks associated with algorithmic trading at various levels in the trading process. These levels include the firm itself, the marketplace and (importantly) exchanges:
 - ✧ The firm itself should have its own risk management structure and risk platform(s)
 - ✧ Pre-trade and post-trade risk controls used in the marketplace

- ✧ Exchanges (i.e., trading platforms) use pre-trade risk controls
 - ✧ Exchanges help their clients manage risk
 - ✧ Exchanges monitor for (and attempt to mitigate) abnormal trading and market manipulation.
-

14. Increased testing of algorithms or trading strategies would be the most appropriate response to which of the following risks?

- I Lagging internal controls.
 - II Rapid occurrence of significant losses.
- A. I only
B. II only
C. Neither I nor II
D. I and II

Answer: B

Mitigating the problem of the rapid occurrence of significant losses could be in the form of increased testing of algorithms or strategies as well as additional proposed requirements by market regulators to improve controls.

15. The concept of defence-in-depth is the primary focus for which of the following activities?

- A. Reporting by the trading desk.
- B. Governance and management oversight.
- C. Testing algorithms and strategies.
- D. Updating and improving controls.

Answer: D

The trading desk focuses on providing relevant reports to one or more of the risk management group, senior management, or the board to allow them to assess the firms total risk.

Governance and management oversight focuses on having a centralized risk management process and the application of controls consistently throughout the firm. Testing of new or revised algorithms or strategies focuses on testing during the development, rollout, and ongoing maintenance stages. A defence-in-depth process includes a wide variety of controls as well as a system of control redundancy throughout the firm in an effort to update and improve controls. Defence- in-depth aims to lower the chances of an erroneous and significant order actually being executed.

16. Firms are most likely to require controls in which of the following trading areas?

- I Order execution.
- II Order generation.
- III Order handling.

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IV Order termination.

- A. 1
- B. 2
- C. 3
- D. 4

Answer: C

The trading department must have controls over order generation, order handling, and order execution. There is no specific mention of order termination.

17. Which of the following parties is least likely to execute trading incident response processes?

- I Control-function group.
 - II Trading desk.
 - III Business-unit management.
- A. I only
 - B. I and II
 - C. III only
 - D. II and III

Answer: D

Control-function groups need to work together to ensure coordinated responses to trading incidents. An individual trading desk or business unit may be the cause of an incident that requires one or more control-function groups to respond to the incident.

Key Point: Hanging Up the Phone

- ETP: electronic trading platform
- AT: automated trading
- HFT: high-frequency trading
- PTFs: Principal trading firms
- CLOB: Central limit order book
- RFQ: request for quote: a multilateral e-version of OTC, do not present algorithms or HFT
- Several factors have been supporting the rise of electronic trading in fixed income markets
- ✧ Reduction in trading costs due to technological advances
- ✧ Changes in the demand for liquidity services
- ✧ Regulatory reforms, which provide both direct and indirect incentives to trade electronically
- Electronification can support market quality by enhancing both price efficiency and market liquidity.
- In traditional fixed income segments, dealers remain the key liquidity providers.

- The new market environment requires new metrics, such as implementation shortfall, to evaluate market liquidity with greater precision.

18. A trading process that provides platform participants with guaranteed prices, usually for smaller transactions is best described as:

- A. Request For Quote (RFQ).
- B. High-Frequency Trading (HFT).
- C. Click To Trade (CTT).
- D. Over-The-Counter (OTC).

Answer: C

A CTT process provides participants with guaranteed prices, usually for smaller transactions.

19. High-frequency trading (HFT) is most likely to be described as:

- I Generating many orders.
 - II Large numbers of orders cancelled.
 - III Open positions being held for very brief periods.
- A. I only
 - B. I and II
 - C. III only
 - D. I, II and III

Answer: D

Trading characteristics of HFT include (1) many orders generated, (2) open positions held for a very short time (e.g., seconds), and (3) cancelling a large number of orders generated (e.g., often over 80%).

20. Which of the following factors is most likely a key driving force behind the electrification of trading in fixed-income markets?

- I Increased regulation.
 - II Lower costs.
 - III Improving market liquidity.
- A. I only
 - B. I and II
 - C. III only
 - D. I, II and III

Answer: D

The main drivers behind electrification are the possibility of lower trading costs and improved market liquidity. Since the financial crisis of 2007—2009, new regulations such as the required

clearing of standardized OTC derivatives, additional trade reporting details, and greater pre- and post-trade transparency have encouraged trading on electronic trading platforms (ETPs).

21. Which of the following statements regarding the impact of electrification on market quality is correct?

- A. Trading algorithms have developed in complexity so as to easily account for significant price changes during periods of market stress.
- B. Principal trading firms are now the main source of liquidity in many fixed- income markets.
- C. Electrification can not assist in exploiting arbitrage opportunities in the market.
- D. During periods of market stress, Principal trading firms maintain narrow bid-ask spreads.

Answer: D

During periods of market stress, PTFs reduced market depth the most, yet kept narrow bid-ask spreads, while bank dealers simply widened their bid-ask spreads. In a quicker electronic environment, arbitrage opportunities can be spotted and profited upon with greater speed. The information is then rapidly incorporated into securities prices, thereby increasing price efficiency. Although there has been a shift from voice to electronic trading, dealers continue to be the main source of liquidity in many fixed-income markets. PTFs that are market makers have taken on the role as a secondary source of liquidity but can only do so for a brief time. The risk involved with trading algorithms may be magnified during periods of market stress. For example, significant price changes during such periods are often challenging to account for in trading algorithms.

Key Point: How have central banks implemented negative policy rates?

- Which banks adopt negative policy rates, and their aims.
 - ✧ ECB and Riksbank aim to encourage inflation.
 - ✧ DN and Swiss aim to counter the surge in demand for their currency.
- Effects of the technical implementation of negative policy rates.
 - ✧ Transmission of negative policy rates to money market: Does not seem to have affected the money market much. The pass-through to short-term money market rates have persisted, and the impact on trading volumes are very small; The problems of positive interest rate money market instruments have so far not materialized.
 - ✧ Transmission beyond money markets: It is difficult to isolate the effect of negative policy rate alone. Banks are reluctant to pass negative rates through to retail depositor; institutional constraints.
- Determine the lower bound for nominal interest rates.
- The risks associate with negative interest rates:
 - ✧ Great uncertainty about the behaviour of individuals and institutions.

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- ✧ Only Euro area and neighbouring economies adopted NIRP, applications in other institutions hard to predict.
- ✧ More recently, the persistent NIRP have reduced banking profitability, the effect has emerged.
- ✧ People should take the risk in consideration.

22. Which of the following central banks have adopted negative policy rates to encourage inflation?

- A. The Swedish central bank.
- B. The Australian central bank.
- C. The Swiss central bank.
- D. The Denmark National Bank.

Answer: A

The European central bank and the Swedish central bank both lowered policy rates into negative territory to encourage inflation. The Australian central bank has not adopted a negative rate regime. The Swiss central bank adopted negative policy rates to combat an appreciating currency started by the ECB's negative rate program. The DN adopted negative policy rates to combat the surge in demand for its currency.

23. Which of the following views about the transmission of negative policy rates is wrong?

- A. Negative policy rates have driven up longer maturity debt instrument prices.
- B. Negative policy rates have passed to the pension funds.
- C. Negative policy rates have reached to non-sovereign money market instruments.
- D. Retail investors have been affected by the negative policy rates.

Answer: D

The introduction of negative policy rate produced low yields for longer maturity debt instruments, thus the prices have gone up. They have been passed along to most wholesale depositors (by commercial banks) like pensions and mutual funds, but not to retail customers. Lending rates for retail customers have actually risen somewhat to offset the negative rates carried by the bank in other depository accounts.

24. About the lower bound for nominal interest rates, which is right?

- A. The theoretical lower bound for interest rates is zero because people can hold cash.
- B. The theoretical lower bound is not impacted by the measure of pass-through to bank customers.
- C. Cash storage has increased a lot after the NIRP programs.
- D. The theoretical lower bound for interest rates is slightly below zero.

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Add / 上海市松花江路2539号复旦科技园1号楼/2号楼 (200437)

Tel / 400-700-9596

Web / WWW.GFEDU.NET

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Answer: D

The theoretical lower bound for interest rates is close to but slightly less than zero to account for storage costs of owning large quantities of cash. The lower bound is greatly impacted by pass-through to customers. If negative rates are passed-through to retail customers, then the true theoretical lower bound might be more apparent as all bank customers would then feel the effect of negative rates. The trouble is that this could create substantial withdrawal requests and move in the opposite direction of the desired stimulus. However, there is not a noticeable increase in cash circulation for the €100, €200, €500 notes, this confirms that cash storage has not increased in the Eurozone since the beginning of NIRP programs.

25. Which of the following statements about consequences of NIRP programs is wrong?

- A. Increased lending rates.
- B. Reduced credibility for central banks.
- C. Lower bank service fees to attract more customers.
- D. Domestic currency depreciation.

Answer: C

The credibility of central banks has been called into question as a result of NIRP programs. One risk of negative interest rate programs is increased lending rates. This occurs when commercial banks decide to not pass along negative rates to retail customers. Increased lending rates will slow the economy and not boost GDP. Another risk is domestic currency depreciation. Negative rates will lower a country's currency with regard to trading partners and potentially lead to currency wars. Also, banks may increase fees to offset the cost of NIRP.

Key Point: Corporation Debt in Emerging Markets

- General Trends of emerging economies over the past decade.
 - ✧ 1999-2007, the balance sheets of emerging economies grew stronger.
 - ✧ Since 2010, the tightening of dollar-funding conditions and a macroeconomic slowdown may result in financial instability.
 - ✧ Global financial conditions are influenced by the stance of U.S. monetary policy.
- Risk factors firms face due to external debt and how they are transferred to the financial system.
 - ✧ Four risks: Maturity risk, Currency risk, Rollover risk, Speculative risk.
 - ✧ Transfer directly: Four channels.
 - ✧ Transfer indirectly: Three channels.
- Case studies: External Commercial Borrowing in India
- Case studies: Foreign Currency Lending to Turkish Companies.

- ✧ Case studies: Corporate bond issuance in Latin America.
- ✧ The risks associated with issuance of corporate debt in emerging economies.

26. Which of the following is a result of the reversal of quantitative easing by the Federal Reserve?

- A. Global borrowing costs will likely decrease.
- B. Emerging market economies will see their balance sheets improve.
- C. An abundant supply of dollars available in global financial markets.
- D. The Federal Reserve will reduce the amount of money it injects into the economy.

Answer: D

When the Federal Reserve reverses quantitative easing, it will taper off and eventually stop injecting money into the economy. Interest rates and borrowing costs will rise, and there will be a tighter supply of dollars available in global markets. Emerging market economies will not see their balance sheets improve as a result of the Fed's actions.

27. The risk a borrower use short-term debt instrument to fund longer-term investments is referred to:

- A. Operation risk.
- B. Rollover risk.
- C. Maturity risk.
- D. Speculative risk.

Answer: C

Maturity risk is borrowers rely on short-term funding for longer-term investments. Borrowers may not be able to renew debt, called rollover risk, as lenders may be sensitive to shifts in financial opportunities in other market segments. Lenders may also be sensitive to macroeconomic, sectoral, or firm-level (projection) shocks. Additionally, lenders may be forced to liquidate positions to meet redemption requests.

28. Corporations in emerging markets have incentive to provide intermediary services not because:

- A. They have low leveraged balance sheets, making lending a low risk venture.
- B. The financial firms have to meet more strict supervisory standards.
- C. Corporation can avoid the regulatory cost.
- D. The corporations can use more leverage.

Answer: A

Corporations in emerging markets have an incentive to borrow then on-lend (i.e., lend money that has been borrowed previously from an organization or person) the funds because they can avoid

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the high regulatory costs borne by financial institutions. They can have high leveraged balance sheet, making lending more profitable.

29. To combat the potential threat to financial stability that results from excessive corporate debt in emerging markets, imposing necessarily stress tests can help with:

- A. Capital.
- B. Liquidity.
- C. Market depth.
- D. Concentration limits issue.

Answer: D

Imposing stress tests can help the banks to govern concentration risk. Banks must have liquid assets sufficient to cover liquidity needs over a 30-day stress period. Run-off rates, the rate at which various deposits will be withdrawn, must be assumed. There are minimum international standards, but supervisors should set run-off rates higher for corporates with greater foreign exchange exposures, again tying it to the company's FX Beta.