# Chapter 5 : Risk Model

# Multiple Choice Questions

# Answers

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## Question 1.

**B is correct.**

Delta and gamma are measures of the movement in an option price, given a movement in the underlying. The other answers can reflect some elements of derivatives risk, but they are not direct measures of the risk.

## Question 2.

VaR is USD 3 million. Expected shortfall (USD) is 10 x 0.6 + 3 x 0.4 = 7.2.

## Question 3.

**D is correct.**

Validation and independent review of stress tests includes a review of both the qualitative and judgmental aspects of stress tests.

Validation and independent review of stress tests should also use expert-based judgment, test data during nonstress periods, and involve communication of stress-test results to all stress-test users.

## Question 4.

A. There is a 1 percent chance that the portfolio will lose at least £4.25 million in any given week.
B. There is a 99 percent chance that the portfolio will lose no more than £4.25 million in one week.

## Question 5.

A. The observed outcomes are consistent with the VAR calculation's prediction on the frequency of losses exceeding the VAR. Therefore, the VAR calculation is accurate.
B. The VAR results indicate that under "normal" market conditions that would characterize 19 out of 20 days, the portfolio ought to lose less than €3 million. It provides no other information beyond this.
C. The portfolio certainly lends itself to scenario analysis. In this particular case, given the substantial short options position, it might be instructive to create a customized scenario under which the portfolio was analyzed in the wake of a large increase in option- implied volatility.

## Question 6.

Rating agencies provide a rating for debt denominated in the local currency and for debt denominated in a foreign currency.

## Question 7.

Reverse stress testing searches for ways in which an organisation can fail.

## Question 8.

**A is correct.**

Countries may decide that the costs of higher inflation are higher (not lower) than the costs of default, so a default is comparatively less expensive. In general, the following factors explain local currency defaults: (1) prior to 1971, the use of the gold standard made it more difficult for some countries to print money, (2) shared currencies including the euro make it impossible for countries to control their own monetary policy, and (3) some counties may conclude that the costs of currency debasement and potentially higher inflation are greater than the costs of default.

## Question 9.

The delta normal model assumes a linear relationship between changes in the value of a portfolio and the changes in the value of the portfolio risk factors. The risk factors follow Normal Distribution.

## Question 10.

**C is correct.**

Scenario analysis and stress testing both examine the performance of a portfolio subject to extreme events. The other two answers are metrics used in portfolio analysis but are not typically associated with extreme events.

## Question 11.

**A is correct.**

A 1% VaR (99% confidence) is the point on the distribution 2.33 standard deviations below the expected value. Answers B and C correctly describe a 16% and 5% VaR, respectively.

## Question 12.

Local currency debt is more highly rated. A country can print money to avoid a default on local currency debt. This makes a default on local currency debt less likely.

## Question 13.

**D is correct.**

Institutions use reverse stress tests to assess the events that are outside of normal business expectations and could threaten the institution's viability.

## Question 14.

**A is correct.**

A smaller tail probability implies a bigger loss. So the 1% weekly VAR is more than the 5% VAR of $3 million.

## Question 15.

**A is correct.**

A 5% decrease in the stock market could easily occur over the course of a few trading sessions and is not as likely to be included in stress-test models as a 300 basis point decline in GDP, a 300 basis point increase in interest rates, or a 5% increase in the unemployment rate.

## Question 16.

A. For the five-year period, there are 60 monthly returns. Of the 60 returns, the 5 percent worst are the 3 worst returns. Therefore, based on the historical method, the 5 percent VAR would be the third worst return. From the returns given, the third worst return is – 0.1980. So, the VAR in dollars is 0.1980($25,000) = $4,950.
B. Of the 60 returns, the 1 percent worst are the 0.6 worst returns. Therefore, we would use the single worst return. From the returns given, the worst return is – 0.2597. So, the VAR in dollars is 0.2597($25,000) = $6,492.50.

## Question 17.

The expected shortfall is the expected loss conditional on the loss being greater than the VaR level.

## Question 18.

C is correct.

Stress testing can serve as an early warning sign of upcoming pressures and risks. The board of directors can take actions that include adjusting capital levels, increasing liquidity, adjusting risks, or engaging in or withdrawing from certain activities.

The board of directors has ultimate oversight responsibility and accountability for an entire institution. Senior management is responsible for implementing authorized stress-testing activities. Senior management should use stress testing, complemented with scenario analysis, to evaluate an institution's risk decisions.

## Question 19.

Because these are the lowest five returns, they represent the 5% lower tail of the "distribution" of 100 historical returns. The fifth lowest return (–0.0019) is the 5% daily VaR. We would say there is a 5% chance of a daily loss exceeding 0.19%, or $190,000.

## Question 20.

**B is correct.**

There is no consensus on how to calculate VaR. A and C are both advantages of VaR, as we noted that VaR is fairly simple to communicate and it can show the contribution of each unit to the overall VaR.

## Question 21.

**D is correct.**

Stress-testing objectives should align with the overall risk management framework for an institution. There is no requirement that the models should be reviewed twice per year. Results should be communicated beyond just senior management and the board. Mild risks are not what stress testing is intended to capture; risks should be extreme.

## Question 22.

A is correct. The VaR measure indicates the probability of a loss of at least a certain level in a time period.

## Question 23.

C is correct. Both A and B risk misestimating the actual results of the scenario because both delta and gamma estimate how an option's value might change for a small move in the underlying asset, not the large movements typically used in a scenario analysis.

## Question 24.

**B is correct.**

## Question 25.

**C is correct.**

Both statements are true. There are multiple methods to estimate VAR and the results do not coincide. Additionally, VAR examines only the lower tail of the distribution and it does not consider the upside benefits.

## Question 26.

**B is correct.**

When the mean return is assumed to be zero, under the variance/covariance method, VaR can be scaled up by multiplying by the square root of time. Hence, annual 1% VaR = $150,000 x √250 = $2,371,708.

## Question 27.

**B is correct.**

The property of subadditivity states that a portfolio made up of subportfolios will have equal or less risk than the sum of the risks of each individual subportfolio.

## Question 28.

**B is correct.**

Institutions should offer incentives for documenting stress tests to ensure that documentation is effective and complete.

Institutions should ensure that other market participants, including management, vendors, and reviewers, adequately document their stress-testing activities. Documentation is useful for both stress-test developers and senior management. Documentation should include a description of the types of stress tests and methodologies, as well as a description of the key assumptions and limitations.

## Question 29.

A. The analytical or variance–covariance method begins with the assumption that portfolio returns are normally distributed. A normal distribution has an unlimited upside and an unlimited downside. The assumption of a normal distribution is inappropriate when the portfolio contains options because the return distributions of options are far from normal. Call options have unlimited upside potential, as in a normal distribution, but the downside return is truncated at a loss of 100 percent. Similarly, put options have a limited upside and a large but limited downside. Likewise, covered calls and protective puts have limits in one direction or the other. Therefore, for the portfolio that has options, the assumption of a normal distribution to estimate VAR has a number of problems. In addition, it is very difficult to calculate a covariance between either two options or an option and a security with more linear characteristics—among other reasons because options have different dynamics at different points in their life cycle.

B. Portfolios with simple, linear characteristics, particularly those with a limited budget for computing resources and analytical personnel, might select the variance/covariance method. For more complex portfolios containing options and time-sensitive bonds, the historical method might be more appropriate. The Monte Carlo simulation method typically would not be a wise choice unless it were managed by an organization with a portfolio of complex derivatives that is willing to make and sustain a considerable investment in technology and human capital.

## Question 30.

**B is correct.**

A key advantage of using stressed risk metrics is that they are conservative. In examining capital adequacy for unexpected losses and considering stressed metrics, the amount of capital is likely to be more than sufficient. In other words, a risk metric that is stressed is likely to be more conservative. A more conservative risk metric does not necessarily mean it is more realistic. One of the disadvantages of using stressed inputs is that the risk metric becomes unresponsive to current market conditions and is more dependent on the investments within the portfolio.

## Question 31.

A is correct.

The historical simulation method estimates VaR based on the historical distribution of the risk factors. B is not correct; the historical simulation method does not rely on any particular distribution because it simply uses whatever distribution applied in the past. C is not correct because the historical distribution does not formally estimate the mean and variance.

## Question 32.

Statement A, which is the definition of VAR, is clearly correct. Statement B is also correct, because it lists the important decisions involved in measuring VAR. Statement D is correct: The longer the time period, the larger the possible losses. Statement C, however, is incorrect. The VAR number would be larger for a 1 percent probability than for a 5 percent probability. Accordingly, the correct answer is C.

## Question 33.

**B is correct.**

Some investors prefer the stability of investing in countries with autocratic governments because government policies are locked in and generally more predictable compared to democratic countries where an election can significantly change government policies. Risks in a democracy are continuous, but usually low. In contrast, risks in a dictatorship are discontinuous. Policies change much less frequently, but changes are often severe and difficult to protect against. Chowdhury is willing to accept the bigger, discontinuous risk as a trade-off for the more frequent, but less damaging, continuous risk.

## Question 34.

**C is correct.**

In the historical method, the portfolio returns are arrayed lowest to highest and the observation at the fifth percentile (95% of the outcomes are better than this outcome) is the VaR. A is not correct because it draws a point on the distribution relative to the expected value rather than the using the 5% of the outcomes that are in the left-most of the distribution. B confuses the parametric and historical methods. In the parametric method, the 5% VaR lies 1.65 standard deviations below the mean.

## Question 35.

**C is correct.**

An internal audit should review the manner in which stress-testing efficiencies are identified, tracked, and remedied.

An internal audit should assess not only the stress-testing activities, but also the staff involved in stress-testing activities. An internal audit does not need to independently assess each stress test used. The internal audit function needs to be independent and objective.

## Question 36.

**A is correct.**

Well-executed VaR measures do adjust for bonds of differing duration, and therefore it is not a limitation of VaR. B is incorrect because VaR ordinarily uses some period of recent history as part of the calculation, and this reliance on history is one of its limitations. C is incorrect because VaR can be inaccurate and underestimate risk if portfolio positions are too large relative to the available market liquidity, and this inability to account for the illiquidity of an individual investor's position is an additional limitation of VaR.

## Question 37.

**D is correct.**

A nonlinear derivative's value is a function of the change in the value of the underlying asset and is dependent on the state of the underlying asset.

## Question 38.

**D is correct.**

Stress tests defined from an institutional perspective do not have to mirror those of external regulations. The expectation is that an institution would have its own stress tests that are used in addition to those defined by external regulations. Actions to be taken based on results, a plan for assessing the results, and revisiting modeling assumptions are appropriate updates to the stress-testing governance process.

## Question 39.

**C is correct.**

Extreme events tend to have a low probability of occurrence with a high impact. Stress testing is designed to show how an institution will respond to these types of events and ensure that they have enough capital and liquid assets to manage during these times.

## Question 40.

**D is correct.**

Stress tests are forward-looking and do not provide probabilities for loss distributions. The time horizons are typically long, only negative events are captured, and the number of extreme scenarios tends to be relatively small.

## Question 41.

**C is correct.**

The expected value if the overall market decreases is 0.4($60) + (1 " 0.4)($55) = $57.

## Question 42.

Sovereign ratings are more stable (except for the lowest rating).

## Question 43.

**A is correct.**

VaR and ES both satisfy all the properties of coherent risk measures for normal distributions. However, only ES satisfies all the properties of coherent risk measures when the assumption of normality is not met.

## Question 44.

**B is correct.**

$10,06699.0% 10-day VaR ($) = $200,000 * 18.0% per annum volatility * SQRT(10/250) * 2.33 deviate * 0.6 delta = $10,065.60 (or $10,049.82, with exact deviate).Or, another perspective: the 99.0% 10-day VaR($) of the asset is given by $200,000 * 18.0% * SQRT(10/250) * 2.33 deviate = $16,776; i.e., the worst expected loss in a position in 10,000 shares. Delta of 0.6 implies a linear estimate of a 0.6 * $16,776 = $10,065.6

## Question 45.

It is less likely to be affected by the ups and downs in the prices of particular goods.

## Question 46.

**D is correct.**

Historically, countries have been more likely to default on foreign bank debt than on sovereign bonds. Defaults were often followed by military actions, but this is not true in recent times. Greater central bank independence means it is more difficult for a country to print money. Over the last 200 years, there are many instances of default.

## Question 47.

**C is correct.**

Because it is the only statement that accurately expresses the VaR. A is incorrect because VaR does not give the likelihood of losing a specific amount. B is incorrect because VaR is not an expected loss— it is a minimum loss.

## Question 48.

Authoritarian governments change less frequency than democratic governments, but when they do change there can be extreme discontinuities in policy.

## Question 49.

A linear portfolio is linearly dependent on the underlying risk factors whereas a non-linear portfolio is not.

## Question 50.

**C is correct.**

VaR measures a minimum loss expected over a holding period a certain percentage of the time. It is not an expected loss nor does it reflect the maximum possible loss, which is the entire equity of the organization.

## Question 51.

**C is correct.**

Ten percent of 180 observations is 18 observations. The return corresponding to the 18th worst monthly return is −23.84%. So, the 10% monthly VAR of this stock is −23.84%. Note that the 10% VAR is smaller in magnitude than the 5% VAR.

## Question 52.

The ten-day VaR is the square root of 10 multiplied by the one-day VaR.

## Question 53.

The list given in the chapter is

- Describe why stress testing is carried out;
- Explain stress-testing procedures to be followed throughout the company;
- Define the roles and responsibilities;
- Define the frequency with which stress testing is to be performed;
- Explain the procedures to be used in defining the selection of scenarios;
- Explain how independent reviews of the stress-testing function will be carried out;
- Provide clear documentation on stress testing to third parties such as regulators, external auditors, and rating agencies as appropriate;
- Indicate how the results of stress testing are to be used and by whom;
- Be updated as appropriate because it is recognized that as market conditions change, stress-testing practices will also change;
- Allow management to track how the results of stress tests change through time; and
- Document the operation of models and other soft- ware acquired from vendors or other third parties.

## Question 54.

The Japanese government owns assets more than other governments.

## Question 55.

**B is correct.**

The method can handle any distribution. A is incorrect because Monte Carlo simulation is not a simple formula. C is incorrect; there is no industry-wide agreement as to the necessary number of simulations.

## Question 56.

**B is correct.**

A contagion effect occurs with a rise in volatility and correlation causing a different return generating process. A specific example of events leading to the breakdown of historical correlation matrices causing a contagion effect is the 2007–2009 global financial crisis. A contagion effect often occurs when volatility and correlations both increase, thus mitigating any diversification benefits.

## Question 57.

**C is correct.**

The delta, or slope, of a linear derivative must be constant (the delta of a nonlinear derivative changes for different levels of the underlying factor). The delta does not necessarily equal to one. A forward contract is an example of a linear derivative. The value of the call option does not change at a constant rate with the change in the value of the underlying stock.

## Question 58.

Printing more money will lead to inflation, which will be bad for the economy.

## Question 59.

**C is correct.**

VaR deals exclusively with left-tail or adverse events. A is wrong because although parametric VaR does generally use the normal distribution, the historical simulation method uses whatever distribution occurred in the past and

Monte Carlo simulation uses whatever distribution the user chooses. B is incorrect because regulators do not specify maximum VaRs, although they may encourage and require that the measure be used.

## Question 60.

The validation and internal review process should carefully evaluate the models and procedures to determine their soundness and that the limitations are acknowledged. The internal audit has a more "big picture" role. It should ensure that stress tests are carried out by well-qualified people and that procedures are consistent across the organization. It looks for ways in which governance, controls, and responsibilities can be improved and provides advice to both senior management and the board.

## Question 61.

**C is correct.**

The Monte Carlo method simulates outcomes using whatever distribution is specified by the user. If a normal distribution is used and a sufficiently large number of simulations are run, the parameters of the Monte Carlo sample will converge with those used in the parametric method, and the overall VaR should be very close to that of the parametric method. A is incorrect because the parametric method is not well- adapted to a non-normal distribution. B is not correct because neither the Monte Carlo method nor the parametric method focus on historical outcomes.

## Question 62.

A debt default makes it difficult for a country to raise money for several years. Investors will be reluctant to buy the debt or equity of firms domiciled in the country. The default may lead to an economic downturn and political instability.

## Question 63.

**B is correct.**

TVAR stands for tail VAR. It's the conditional tail expectation. It is defined as the VAR plus the expected loss in excess of VAR conditional on such loss occurs. Unlike VAR which measures the minimum amount of loss, TVAR measures the expected size of loss conditional on the loss is greater than VAR.

## Question 64.

Correlations usually increase in stressed market conditions.

## Question 65.

The board should define how stress testing is to be carried out within a financial institution. Senior management is responsible for ensuring that the stress-testing activities authorized by the board are carried out.

## Question 66.

**A is correct.**

The parameters of a normal distribution are the expected value and standard deviation. Skewness, as mentioned in B and C, and kurtosis as mentioned in B, are characteristics used to describe a non-normal distribution.

## Question 67.

It should focus on capital and liquidity.

## Question 68.

Debt-to-GDP ratio, social security commitments, the tax base, and political risk.

## Question 69.

It would be the fourth worst loss.

## Question 70.

**A.** Of the 700 outcomes, the worst 5 percent are the 35 worst returns. Therefore, the 5 percent VAR would be the 35th worst return. From the data given, the 35th worst return is –0.223. So, the 5 percent annual VAR in dollars is 0.223($10,000,000) = $2,230,000.

**B.** Of the 700 outcomes, the worst 1 percent are the 7 worst returns. Therefore, the 1 percent VAR would be the seventh worst return. From the data given, the seventh worst return is – 0.347. So, the 1 percent annual VAR in dollars is 0.347($10,000,000) = $3,470,000.

## Question 71.

**B is correct.**

Scenario measures do not assume any given distribution, and thus this is not a limitation of scenario analysis. A is incorrect because it is in fact difficult to ascribe probability to many scenarios, and thus this is a limitation of scenario analysis. C is also incorrect because it is in fact impossible to measure all possible future scenarios, and this is a limitation of scenario analysis.

## Question 72.

VaR is the loss that will not be exceeded over a certain period with a certain probability. The probability is referred to as the confidence level.

## Question 73.

A CA candidate would know that 5% in a single tail is associated with 1.645, or approximately 1.65, standard deviations from the mean expected return. Therefore, the 5% annual VaR is:

$$\begin{aligned}
\text{VAR} &= \left[R_p - (z)(\sigma)\right]V_p \\
&= \left[6.0\% - 1.65(12.0\%)\right](\$100,000,000) \\
&= -13.8\%(\$100,000,000) \\
&= -\$13,800,000
\end{aligned}$$

where :

$R_p$ = expected return on the portfolio

$V_p$ = value of the portfolio

z = z – value corresponding with the desired level of significance

σ = standard deviation of returns

The interpretation is that there is 5% probability that the annual loss will exceed $13.8 million and a 95% probability the annual loss will be less.

## Question 74.

The homogeneity axiom states that changing the size of a portfolio by multiplying all its components by A results in the risk measure being multiplied by A. The subadditivity axiom states that for any two portfolios, A and B, the risk measure for the portfolio formed by merging A and B should be not greater than the sum of the risk measures for portfolios A and B.

## Question 75.

The delta-normal model does not consider the curvature of the relationship between the portfolio value and individual risk factors.

## Question 76.

The countries that have defaulted are Jamaica, Greece, Belize, Cyprus, Argentina, Ukraine, and Mozambique.

## Question 77.

A coherent risk measure is a risk measure that has satisfied four specified axioms.

## Question 78.

VaR is 35. Expected shortfall is 37.5.

## Question 79.

The standard deviation of the daily changes in the assets are (in USD) 100 and 400. The standard deviation of the daily change in the portfolio is

$$\sqrt{100^2 + 400^2 + 2 \times 100 \times 400 \times 0.3} = 440.5$$

The standard deviation of the five-day change is the square root of 5 multiplied by the one-day standard deviation, which is USD 984.9. The 97% VaR is 1.88 times this, which is USD 1852.4.

## Question 80.

Property rights, the enforcement of contracts, and the time it takes to resolve disputes.

## Question 81.

Losses (USD) of 20, 13, 9, 6, 2, and - 2 have probabilities of 0.0009, 0.0042, 0.054, 0.0049, 0.126, and 0.81, respectively. The VaR is 9 and ES is

$$\frac{0.0009 \times 20 + 0.0042 \times 13 + (0.05 - 0.0009 - 0.0042) \times 9}{0.05}$$
$$= 9.534$$

## Question 82.

VaR does not satisfy the subadditivity condition because the VaR for two portfolios combined (9) is greater than the sum of the VaR for each portfolio individually (i.e., 9 > 3 + 3). Meanwhile, expected shortfall does satisfy the condition because its value for the two portfolios combined is less than the sum of each portfolio's expected shortfall (i.e., 9.534 < 7.2 + 7.2).

## Question 83.

VaR provides a high percentile of the distribution of losses over a short period based on recent history. Stressed VaR provides a high percentile of the distribution of losses over a short period conditional on a repeat of a stressed period. Stress testing evaluates the outcome from a particular stress scenario over a longer period.

## Question 84.

The Basel Committee observes that in some cases the board and senior management were not sufficiently involved, stress testing was a mechanical exercise, exposures were not aggregated to produce an enterprise-wide view, knock-on effects were not considered, stress tests were too mild and not long enough in duration, correlations were under-estimated, and there was too much reliance on historical data and not enough consideration of new products and new positions being taken.

## Question 85.

This is not true. Scenarios should not be chosen mechanically. They should be adjusted as the business environment changes.

## Question 86.

The board makes key strategic decisions on what should be done and how it should be done. Senior management is responsible for implementing the decisions and reporting back. This is true in stress testing and other areas. If the same person leads senior management and the board, the separation of the responsibilities is not as clear-cut.

## Question 87.

Stressed VaR calculates a percentile of the distribution of losses over a short period of time conditional on a stressed scenario from the past recurring. Stressed ES is the average loss conditional on the loss being greater than the stressed VaR level in the stressed scenario. Stress testing looks at the full consequences of a particular stress

scenario that may or may not have occurred in the past. The time horizon is usually much longer than for stressed VaR/ES.

## Question 88.

**Answer D.**

## Question 89.

**Answer C.**

## Question 90.

**Answer C.**

## Question 91.

**Answer C.**

## Question 92.

**Answer C.**

## Question 93.

**Answer B.**

## Question 94.

**Answer A.**

## Question 95.

**Answer B.**

## Question 96.

**Answer D.**

## Question 97.

**Answer D.**

## Question 98.

**Answer B.**

## Question 99.

**Answer D.**

## Question 100.

**Answer B.**

## Question 101.

**Answer A.**

## Question 102.

**Answer C.**

## Question 103.

**Answer D.**

## Question 104.

**Answer D.**

## Question 105.

**Answer D.**

## Question 106.

**Answer E.**

## Question 107.

**Answer C.**

## Question 108.

**Answer A.**

## Question 109.

**Answer B.**

## Question 110.

**Answer D.**

## Question 111.

**Answer A.**