

Q1.

An investment bank owns equities with a current market value of \$1m. The fund manager wishes to estimate the **Value at Risk** over a 10-day period at the 5% lower tail level. She does so assuming that the investment returns on the equities over a 10-day period are normally distributed with a standard deviation of 5%. The mean return is assumed to be zero, which assumption is often made in practice when calculating the **Value at Risk** over such a short time period.

Calculate the 10-Day VaR.

Q2.

Consider a new hedge fund that is about to invest \$100k in high-risk information technology (IT) shares. Based on the available historical performance data, the annual investment return on similar existing hedge funds investing in IT shares is assumed to follow a normal distribution with mean 10% *pa* and standard deviation 20% *pa*.

- (i) Use the above information to calculate the hedge fund's 1-year **Value at Risk** based on the 5% lower tail. [2]
 - (ii) Comment in detail on the validity of your calculation in (i). [5]
 - (iii) The hedge fund now decides to leverage its returns by borrowing \$100k at a fixed rate of 5% *pa*, the new money being invested entirely in additional IT shares. Calculate the increase in the hedge fund's estimated 1-year **Value at Risk** based on the 5% lower tail due to leveraging. [2]
- [Total 9]

Q3.

- (i) Define **Value at Risk**. [1]
- (ii) Calculate the **Value at Risk** at the 5% significance level over a 30-day period for a portfolio of £500m equity shares and £300m of bonds. You should assume the following:
 - the annual return on equities $R_e \sim N(10\%, (14\%)^2)$
 - the annual return on bonds $R_b \sim N(5\%, (8\%)^2)$
 - the correlation between bonds and equities is 0.6. [4]
- (iii) Discuss the drawbacks of using this calculation to measure the risk of the portfolio. [5]

Q4.

- i. What are the Drawbacks of Value at Risk?
- ii. Compare Historical VaR, Parametric VaR and Monte Carlo VaR

Q5. Calculate the 5% Daily VaR on the portfolio. Assume 252 Trading days in a year.

		Annualized	
	Allocation	Return	Standard Deviation
SPY	80%	10.5%	20.0%
SPLB	20%	6.0%	8.5%

Note: The correlation of SPLB and SPY = -0.06.

Q6

1. The parameters of normal distribution required to estimate parametric VaR are:

- A. expected value and standard deviation.
- B. skewness and kurtosis.
- C. standard deviation and skewness.

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2. Assuming a daily expected return of 0.0384% and daily standard deviation of 1.0112% (as in the example in the text), which of the following is *closest* to the 1% VaR for a \$150 million portfolio? Express your answer in dollars.

- A. \$3.5 million
- B. \$2.4 million
- C. \$1.4 million

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3. Assuming a daily expected return of 0.0384% and daily standard deviation of 1.0112% (as in the example in the text), the daily 5% parametric VaR is \$2,445,150. Rounding the VaR to \$2.4 million, which of the following values is *closest* to the annual 5% parametric VaR? Express your answer in dollars.

- A. \$38 million
- B. \$25 million
- C. \$600 million

Q7

Historical Simulation VaR

1. Which of the following statements about the historical simulation method of estimating VaR is *most* correct?
- A. A 5% historical simulation VaR is the value that is 5% to the left of the expected value.
 - B. A 5% historical simulation VaR is the value that is 1.65 standard deviations to the left of the expected value.
 - C. A 5% historical simulation VaR is the fifth percentile, meaning the point on the distribution beyond which 5% of the outcomes result in larger losses.

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2. Which of the following is a limitation of the historical simulation method?
- A. The past may not repeat itself.
 - B. There is a reliance on the normal distribution.
 - C. Estimates of the mean and variance could be biased.

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Q8

Monte Carlo Simulation VaR

1. When will the Monte Carlo method of estimating VaR produce virtually the same results as the parametric method?
- A. When the Monte Carlo method assumes a non-normal distribution.
 - B. When the Monte Carlo method uses the historical return and distribution parameters.
 - C. When the parameters and the distribution used in the parametric method are the same as those used in the Monte Carlo method and the Monte Carlo method uses a sufficiently large sample.

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2. Which of the following is an advantage of the Monte Carlo method?
- A. The VaR is easy to calculate with a simple formula.
 - B. It is flexible enough to accommodate many types of distributions.
 - C. The number of necessary simulations is determined by the parameters.

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Q9

1. Which of the following is **not** an advantage of VaR?

- A. It is a simple concept to communicate.
- B. There is widespread agreement on how to calculate it.
- C. It can be used to compare risk across portfolios or trading units.

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2. Which of the following is a limitation of VaR?

- A. It requires the use of the normal distribution.
- B. The maximum VaR is prescribed by federal securities regulators.
- C. It focuses exclusively on potential losses, without considering potential gains.

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Q10

1. Conditional VaR measures the:

- A. VaR over all possible losses.
- B. VaR under normal market conditions.
- C. average loss, given that VaR is exceeded.

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2. Which of the following correctly identifies incremental VaR?

- A. The change in VaR from increasing a position in an asset.
- B. The increase in VaR that might occur during extremely volatile markets.
- C. The difference between the asset with the highest VaR and the asset with the second highest VaR.

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3. Which of the following statements is correct about marginal VaR?

- A. The marginal VaR is the same as the incremental VaR.
- B. The marginal VaR is the VaR required to meet margin calls.
- C. Marginal VaR estimates the change in VaR for a small change in a given portfolio holding.

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Q11

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

Eastern Regional Bank Fixed-Income Investment Portfolio

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

Exhibit 1: US Treasury Barbell Portfolio

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

Trust Department's Equity Fund

- a. **Use of Options:** The trust department of Eastern Regional Bank manages an equity fund called the Index Plus Fund, with \$325 million in assets. This fund's objective is to track the S&P 500 Index price return while producing an income return 1.5 times that of the S&P 500. The bank's chief investment officer (CIO) uses put and call options on S&P 500 stock index futures to adjust the risk exposure of certain client accounts that have an investment in this fund. The portfolio of a 60-year-old widow with a below-average risk tolerance has an investment in this fund, and the CIO has asked his assistant, Janet Ferrell, to propose an options strategy to bring the portfolio's delta to 0.90.
- b. **Value at Risk:** The Index Plus Fund has a value at risk (VaR) of \$6.5 million at 5% for one day. Gorver asks Abell to write a brief summary of the portfolio VaR for the report he is preparing on the fund's risk position.

Combined Bank Risk Exposures

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

Practice Problem

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

- A.** Conditional VaR, stress test, and scenario analysis
- B.** Monte Carlo VaR, incremental VaR, and stress test
- C.** Parametric VaR, marginal VaR, and scenario analysis

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

- A.** a minimum daily loss of \$1.10 million over the next year.
- B.** a loss over one month equal to or exceeding \$5.37 million 5% of the time.
- C.** an average daily loss of \$1.10 million 5% of the time during the next 250 trading days.

Q12

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

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

Exhibit 1: Flusk Portfolio VaR (in \$ millions)

Confidence Interval	Daily VaR	Monthly VaR
95%	1.10	5.37

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

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

- A.** using a standard normal distribution in the VaR model.
- B.** using a 95% confidence interval instead of a 99% confidence interval.
- C.** lower market volatility during the last year compared with the lookback period.

Q13

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

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

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

- A.** Relative VaR
- B.** Incremental VaR
- C.** Conditional VaR

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

- A.** Marginal VaR
- B.** Full revaluation of securities
- C.** The use of sensitivity risk measures

Q. The risk management tool referenced in Ming's question:

- A.** is widely accepted by regulators.
- B.** takes into account asset liquidity.
- C.** usually incorporates right-tail events.

Q14

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

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

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

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

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

- A.** parametric method.
- B.** historical simulation method.
- C.** Monte Carlo simulation method.

Q. In Statement 2, Kynnersley implies that the portfolio:

- A.** is at risk of losing \$4,500 each trading day.
- B.** value is expected to decline by \$90,000 or more once in 20 trading days.
- C.** has a 5% chance of falling in value by a maximum of \$90,000 on a single trading day.

Q15

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

Exhibit 1: Equity Opportunities Fund—VaR Model Input Assumptions

	Large-Cap ETF	Energy ETF	Total Portfolio
Portfolio weight	65.0%	35.0%	100.0%
Expected annual return	12.0%	18.0%	14.1%
Standard deviation	20.0%	40.0%	26.3%
Correlation between ETFs: 0.90			
Number of trading days/year: 250			

Practice Problem

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

- A. 1.61%.
- B. 2.42%.
- C. 2.69%.

Q16

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

Exhibit 2: VaR Input Assumptions for Proposed CAD260 Million Portfolio

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

Hamilton elects to apply a one-day, 5% VaR limit of CAD2 million in her risk assessment of LICIA's portfolio. This limit is consistent with the risk tolerance the committee has specified for the Hiram portfolio.

Practice Problem

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

- A. CAD17 million.
- B. CAD31 million.
- C. CAD48 million.

Q17

Later that day, Woolridge receives an email from Alexander asking her to estimate the dollar VaR at the 5% level for the firm's developing market equity fund. Woolridge estimates VaR using the parametric method (assuming normal distribution) with the inputs in Exhibit 1.

Exhibit 1 Data for Developing Market Equity Fund

Portfolio value	\$500 million
Daily expected return	0.04%
Daily expected volatility	1.30%

Q. Using the inputs in Exhibit 1, Woolridge's estimate of VaR is *most likely* closest to:

- A. \$6.5 million.
- B. \$18.9 million.
- C. \$10.5 million.

Q18.

How is Marginal VaR different from incremental VaR?

Q19.

Consider a portfolio M which has three equally weighted securities 1, 2, and 3. Each security has a value of \$100,000. Assume that the portfolio VaR is \$20,000.

Given that security 2 has a beta of 1.5, calculate the marginal VaR of security 2.

Q20 Calculate the Incremental VaR using full revaluation

Consider a portfolio composed of two foreign currencies, namely USD and EUR. Assume that these currencies are uncorrelated and have volatility against the dollar of 5% and 10%, respectively. The portfolio has US\$4 million invested in the USD and US\$3 million in EUR.

At a 95% confidence level, find the incremental VaR given that the USD currency increases by US\$15,000.