

VALUATION AND RISK MODELS

PART I EXAM WEIGHT | 30% (VRM)

This area focuses on valuation techniques and risk models. The broad knowledge points covered in Valuation and Risk Models include the following:

- Value-at-Risk (VaR)
- Expected shortfall (ES)
- Estimating volatility and correlation
- Economic and regulatory capital
- Stress testing and scenario analysis
- Option valuation
- Fixed-income valuation
- Hedging
- Country and sovereign risk models and management
- External and internal credit ratings
- Expected and unexpected losses
- Operational risk

The readings that you should focus on for this section and the specific learning objectives to achieve with each reading are:

Global Association of Risk Professionals. *Valuation and Risk Models*. New York, NY: Pearson, 2022.

Chapter 1. Measures of Financial Risk [VRM-1]

After completing this reading, you should be able to:

- Describe the mean-variance framework and the efficient frontier.
- Compare the normal distribution with the typical distribution of returns of risky financial assets such as equities.
- Define the VaR measure of risk, describe assumptions about return distributions and holding periods, and explain the limitations of VaR.
- Explain and calculate ES and compare and contrast VaR and ES.
- Define the properties of a coherent risk measure and explain the meaning of each property.
- Explain why VaR is not a coherent risk measure.

Chapter 2. Calculating and Applying VaR [VRM-2]

After completing this reading, you should be able to:

- Explain and give examples of linear and non-linear portfolios.
- Describe and explain the historical simulation approach for computing VaR and ES.
- Describe the delta-normal approach and use it to calculate VaR for non-linear derivatives.
- Describe and calculate VaR for linear derivatives.

- Describe the limitations of the delta-normal method.
- Explain the Monte Carlo simulation method for computing VaR and ES and identify its strengths and weaknesses.
- Describe the implications of correlation breakdown for a VaR or ES analysis.
- Describe worst-case scenario analysis and compare it to VaR.

Chapter 3. Measuring and Monitoring Volatility [VRM-3]

After completing this reading, you should be able to:

- Explain how asset return distributions tend to deviate from the normal distribution.
- Explain reasons for fat tails in a return distribution and describe their implications.
- Distinguish between conditional and unconditional distributions and describe regime switching.
- Compare and contrast different approaches for estimating conditional volatility.
- Apply the exponentially weighted moving average (EWMA) approach to estimate volatility, and describe alternative approaches to weighting historical return data.
- Apply the GARCH (1,1) model to estimate volatility.
- Explain and apply approaches to estimate long horizon volatility/VaR and describe the process of mean reversion according to a GARCH (1,1) model.
- Evaluate implied volatility as a predictor of future volatility and its shortcomings.
- Describe an example of updating correlation estimates.

Chapter 4. External and Internal Credit Ratings [VRM-4]

After completing this reading, you should be able to:

- Describe external rating scales, the rating process, and the link between ratings and default.
- Define conditional and unconditional default probabilities and explain the distinction between the two.
- Define hazard rate and use it to calculate the unconditional default probability of a credit asset.
- Define recovery rate and calculate the expected loss from a loan.
- Explain and compare the through-the-cycle and point-in-time ratings approaches.
- Describe alternative methods to credit ratings produced by rating agencies.
- Compare external and internal ratings approaches.
- Describe and interpret a rating transition matrix and explain its uses.
- Describe the relationships between changes in credit ratings and changes in stock prices, bond prices, and credit default swap spreads.
- Explain historical failures and potential challenges to the use of credit ratings in making investment decisions.

Chapter 5. Country Risk: Determinants, Measures, and Implications [VRM-5]

After completing this reading, you should be able to:

- Explain how a country's economic growth rates, political risk, legal risk, and economic structure relate to its risk exposure.
- Evaluate composite measures of risk that incorporate multiple components of country risk.
- Compare instances of sovereign default in both foreign currency debt and local currency debt and explain common causes of sovereign defaults.
- Describe the consequences of sovereign default.
- Describe factors that influence the level of sovereign default risk; explain and assess how rating agencies measure sovereign default risks.
- Describe the characteristics of sovereign credit spreads and sovereign credit default swaps (CDS) and compare the use of sovereign spreads to credit ratings.

Chapter 6. Measuring Credit Risk [VRM-6]

After completing this reading, you should be able to:

- Explain the distinctions between economic capital and regulatory capital and describe how economic capital is derived.
- Describe the degree of dependence typically observed among the loan defaults in a bank's loan portfolio, and explain the implications for the portfolio's default rate.
- Define and calculate expected loss (EL).
- Define and explain unexpected loss (UL).
- Estimate the mean and standard deviation of credit losses assuming a binomial distribution.
- Describe the Gaussian copula model and its application.
- Describe and apply the Vasicek model to estimate default rate and credit risk capital for a bank.
- Describe the CreditMetrics model and explain how it is applied in estimating economic capital.
- Describe and use Euler's theorem to determine the contribution of a loan to the overall risk of a portfolio.
- Explain why it is more difficult to calculate credit risk capital for derivatives than for loans.
- Describe challenges to quantifying credit risk.

Chapter 7. Operational Risk [VRM-7]

After completing this reading, you should be able to:

- Describe the different categories of operational risk and explain how each type of risk can arise.
- Compare the basic indicator approach, the standardized approach, and the advanced measurement approach for calculating operational risk regulatory capital.
- Describe the standardized measurement approach and explain the reasons for its introduction by the Basel Committee.
- Explain how a loss distribution is derived from an appropriate loss frequency distribution and loss severity distribution using Monte Carlo simulation.
- Describe the common data issues that can introduce inaccuracies and biases in the estimation of loss frequency and severity distributions.
- Describe how to use scenario analysis in instances when data are scarce.
- Describe how to identify causal relationships and how to use Risk and Control Self-Assessment (RCSA), Key Risk Indicators (KRIs), and education to understand and manage operational risks.
- Describe the allocation of operational risk capital to business units.
- Explain how to use the power law to measure operational risk.
- Explain how the moral hazard and adverse selection problems faced by insurance companies relate to insurance against operational risk.

Chapter 8. Stress Testing [VRM-8]

After completing this reading, you should be able to:

- Describe the rationale for the use of stress testing as a risk management tool.
- Describe the relationship between stress testing and other risk measures, particularly in enterprise-wide stress testing.
- Describe stressed VaR and stressed ES, including their advantages and disadvantages, and compare the process of determining stressed VaR and ES to that of traditional VaR and ES.
- Explain key considerations and challenges related to developing stress testing scenarios and building stress testing models.
- Describe reverse stress testing and describe an example of regulatory stress testing.
- Describe the responsibilities of the board of directors, senior management, and the internal audit function in stress testing governance.
- Describe the role of policies and procedures, validation, and independent review in stress testing governance.
- Describe the Basel stress testing principles for banks regarding the implementation of stress testing.

Chapter 9. Pricing Conventions, Discounting, and Arbitrage [VRM-9]

After completing this reading, you should be able to:

- Define discount factor and use a discount function to compute present and future values.
- Define the “law of one price,” explain it using an arbitrage argument, and describe how it can be applied to bond pricing.
- Identify arbitrage opportunities for fixed-income securities with certain cash flows.
- Identify the components of a U.S. Treasury coupon bond and compare the structure to Treasury STRIPS, including the difference between P-STRIPS and C-STRIPS.
- Construct a replicating portfolio using multiple fixed-income securities to match the cash flows of a given fixed-income security.
- Differentiate between “clean” and “dirty” bond pricing and explain the implications of accrued interest with respect to bond pricing.
- Describe the common day-count conventions used to compute interest on a fixed-income security.

Chapter 10. Interest Rates [VRM-10]

After completing this reading, you should be able to:

- Calculate and interpret the impact of different compounding frequencies on a bond's value.
- Define spot rate and compute discount factors given spot rates.
- Interpret the forward rate and compute forward rates given spot rates.
- Define par rate and describe how to determine the par rate of a bond.
- Interpret the relationship between spot, forward, and par rates.
- Assess the impact of a change in time to maturity on the price of a bond.
- Define the “flattening” and “steepening” of rate curves and describe a trade to reflect expectations that a curve will flatten or steepen.
- Describe a swap transaction and explain how a swap market defines par rates.

Chapter 11. Bond Yields and Return Calculations [VRM-11]

After completing this reading, you should be able to:

- Distinguish between gross and net realized returns and calculate the realized return for a bond over a holding period including reinvestments.
- Define and interpret the spread of a bond and explain how a spread is derived from a bond price and a term structure of rates.
- Define, interpret, and apply a bond's yield to maturity (YTM) to bond pricing.
- Explain how to compute a bond's YTM given its structure and price.
- Calculate the price of an annuity and a perpetuity.
- Explain the relationship between spot rates and YTM.
- Define the coupon effect and explain the relationship between coupon rate, YTM, and bond prices.
- Explain the decomposition of the profit and loss (P&L) for a bond position or portfolio into separate factors including carry roll-down, rate change, and spread change effects.
- Describe the common assumptions made about interest rates when calculating carry roll-down, and calculate carry roll-down under these assumptions.

Chapter 12. Applying Duration, Convexity, and DV01 [VRM-12]

After completing this reading, you should be able to:

- Describe a one-factor interest rate model and identify common examples of interest rate factors.
- Define and compute the DV01 of a fixed-income security given a change in rates and the resulting change in price.

- Calculate the face amount of bonds required to hedge an interest rate-sensitive position given the DV01 of each.
- Define, compute, and interpret the effective duration of a fixed-income security given a change in rates and the resulting change in price.
- Compare and contrast DV01 and effective duration as measures of price sensitivity.
- Define, compute, and interpret the convexity of a fixed-income security given a change in rates and the resulting change in price.
- Calculate the DV01, duration, and convexity of a portfolio of fixed-income securities.
- Explain the hedging of a position based on effective duration and convexity.
- Construct a barbell portfolio to match the cost and duration of a given bullet investment and explain the advantages and disadvantages of bullet and barbell portfolios.

Chapter 13. Modeling Non-Parallel Term Structure Shifts and Hedging [VRM-13]

After completing this reading, you should be able to:

- Describe principal components analysis and explain its use in understanding term structure movements.
- Describe key rate shift analysis and define key rate 01 (KR01).
- Calculate the KR01s of a portfolio given a set of key rates.
- Compute the positions in hedging instruments necessary to hedge the key rate risks of a portfolio.
- Apply key rate analysis and principal components analysis to estimating portfolio volatility.
- Describe an interest rate bucketing approach, define forward bucket 01, and compare forward bucket 01s to KR01s.
- Calculate the corresponding duration measure given a KR01 or forward bucket 01.

Chapter 14. Binomial Trees [VRM-14]

After completing this reading, you should be able to:

- Calculate the value of an American and a European call or put option using a one-step and two-step binomial model.
- Describe how volatility is captured in the binomial model.
- Describe how the value calculated using a binomial model converges as time periods are added.
- Define and calculate delta of a stock option.
- Explain how the binomial model can be altered to price options on stocks with dividends, stock indices, currencies, and futures.

Chapter 15. The Black-Scholes-Merton Model [VRM-15]

After completing this reading, you should be able to:

- Explain the lognormal property of stock prices, the distribution of rates of return, and the calculation of expected return.
- Compute the realized return and historical volatility of a stock.
- Describe the assumptions underlying the Black-Scholes-Merton option pricing model.
- Compute the value of a European option on a non-dividend-paying stock using the Black-Scholes-Merton model.
- Define implied volatilities and describe how to compute implied volatilities from market prices of options using the Black-Scholes-Merton model.
- Explain how dividends affect the decision to exercise early for American call and put options.
- Compute the value of a European option on a dividend-paying stock, futures, or foreign currency using the Black-Scholes-Merton model.
- Describe warrants, calculate the value of a warrant, and calculate the dilution cost of the warrant to existing shareholders.

Chapter 16. Option Sensitivity Measures: The “Greeks” [VRM-16]

After completing this reading, you should be able to:

- Describe and assess the risks associated with naked and covered option positions.
- Describe the use of a stop-loss hedging strategy, including its advantages and disadvantages, and explain how this strategy can generate naked and covered option positions.
- Compute the delta of an option.
- Explain delta hedging for an option position, including its dynamic aspects.
- Define and describe vega, gamma, theta, and rho for option positions and calculate the gamma and vega of an option.
- Explain how to implement and maintain a delta-neutral and gamma-neutral position.
- Describe the relationship between delta, theta, gamma, and vega.
- Calculate the delta, gamma, and vega of a portfolio.
- Describe how to implement portfolio insurance and how this strategy compares with delta hedging.