Quantitative Methods

LEARNING OUTCOMES

Rates and Returns

The candidate should be able to:

- interpret interest rates as required rates of return, discount rates, or opportunity costs and explain an interest rate as the sum of a real risk-free rate and premiums that compensate investors for bearing distinct types of risk
- calculate and interpret different approaches to return measurement over time and describe their appropriate uses
- compare the money-weighted and time-weighted rates of return and evaluate the performance of portfolios based on these measures
- calculate and interpret annualized return measures and continuously compounded returns, and describe their appropriate uses
- calculate and interpret major return measures and describe their appropriate uses

Time Value of Money in Finance

The candidate should be able to:

- calculate and interpret the present value (PV) of fixed-income and equity instruments based on expected future cash flows
- calculate and interpret the implied return of fixed-income instruments and required return and implied growth of equity instruments given the present value (PV) and cash flows
- explain the cash flow additivity principle, its importance for the no-arbitrage condition, and its use in calculating implied forward interest rates, forward exchange rates, and option values

Statistical Measures of Asset Returns

The candidate should be able to:

- calculate, interpret, and evaluate measures of central tendency and location to address an investment problem
- calculate, interpret, and evaluate measures of dispersion to address an investment problem
- interpret and evaluate measures of skewness and kurtosis to address an investment problem
- interpret correlation between two variables to address an investment problem

Probability Trees and Conditional Expectations

The candidate should be able to:

- calculate expected values, variances, and standard deviations and demonstrate their application to investment problems
- formulate an investment problem as a probability tree and explain the use of conditional expectations in investment application
- calculate and interpret an updated probability in an investment setting using Bayes' formula

Portfolio Mathematics

The candidate should be able to:

- calculate and interpret the expected value, variance, standard deviation, covariances, and correlations of portfolio returns
- calculate and interpret the covariance and correlation of portfolio returns using a joint probability function for returns
- define shortfall risk, calculate the safety-first ratio, and identify an optimal portfolio using Roy's safety-first criterion

Simulation Methods

The candidate should be able to:

- explain the relationship between normal and lognormal distributions and why the lognormal distribution is used to model asset prices when using continuously compounded asset returns
- describe Monte Carlo simulation and explain how it can be used in investment applications
- describe the use of bootstrap resampling in conducting a simulation based on observed data in investment applications

Estimation and Inference

The candidate should be able to:

- compare and contrast simple random, stratified random, cluster, convenience, and judgmental sampling and their implications for sampling error in an investment problem
- explain the central limit theorem and its importance for the distribution and standard error of the sample mean
- describe the use of resampling (bootstrap, jackknife) to estimate the sampling distribution of a statistic

Hypothesis Testing

The candidate should be able to:

- explain hypothesis testing and its components, including statistical significance, Type I and Type II errors, and the power of a test
- construct hypothesis tests and determine their statistical significance, the associated Type I and Type II errors, and power of the test given a significance level
- compare and contrast parametric and nonparametric tests, and describe situations where each is the more appropriate type of test

Parametric and Non-Parametric Tests of Independence

The candidate should be able to:

- explain parametric and nonparametric tests of the hypothesis that the population correlation coefficient equals zero, and determine whether the hypothesis is rejected at a given level of significance
- explain tests of independence based on contingency table data

Simple Linear Regression

The candidate should be able to:

- describe a simple linear regression model, how the least squares criterion is used to estimate regression coefficients, and the interpretation of these coefficients
- explain the assumptions underlying the simple linear regression model, and describe how residuals and residual plots indicate if these assumptions may have been violated
- calculate and interpret measures of fit and formulate and evaluate tests of fit and of regression coefficients in a simple linear regression
- describe the use of analysis of variance (ANOVA) in regression analysis, interpret ANOVA results, and calculate and interpret the standard error of estimate in a simple linear regression
- calculate and interpret the predicted value for the dependent variable, and a prediction interval for it, given an estimated linear regression model and a value for the independent variable
- describe different functional forms of simple linear regressions

Introduction to Big Data Techniques

The candidate should be able to:

- describe aspects of "fintech" that are directly relevant for the gathering and analyzing of financial data
- describe Big Data, artificial intelligence, and machine learning
- describe applications of Big Data and Data Science to investment management