

Quantitative Methods for Finance

Module 1: The Time Value of Money

- 1 Learning how to interpret interest rates as required rates of return, discount rates, or opportunity costs.
- 2 Learning how to explain an interest rate as the sum of a real risk-free rate, expected inflation, and premiums that compensate investors for distinct types of risk.
- 3 Learning how to calculate and interpret the effective annual rate, given the stated annual interest rate and the frequency of compounding.
- 4 Learning how to solve time value of money problems for different frequencies of compounding.
- 5 Learning how to calculate and interpret the future value (FV) and present value (PV) of a single sum of money, an ordinary annuity, an annuity due, a perpetuity (PV only), and a series of unequal cash flows.
- 6 Learning how to demonstrate the use of a time line in modeling and solving time value of money problems.

Module 2: Discounted Cash Flow Applications

- 1 Learning how to calculate and interpret the net present value (NPV) and the internal rate of return (IRR) of an investment.
- 2 Learning how to contrast the NPV rule to the IRR rule and identify problems associated with the IRR rule.
- 3 Learning how to define, calculate, and interpret a Holding Period Return (total return).
- 4 Learning how to calculate, interpret, and distinguish between the money-weighted and time-weighted rates of return of a portfolio and appraise the performance of portfolios based on these measures.

- 5 Learning how to calculate and interpret the bank discount yield, holding period yield, effective annual yield, and money market yield for a U.S. Treasury bill.
- 6 Learning how to convert among Holding Period Yield, Money Market Yield, Effective Annual Yield, and Bond Equivalent Yield.

Module 3: Statistical Concepts and Market Returns

- 1 Learning how to distinguish between descriptive statistics and inferential statistics, between a population and a sample, and among the types of measurement scales.
- 2 Learning how to define a parameter, a sample statistic, and a frequency distribution.
- 3 Learning how to calculate and interpret relative frequencies and cumulative relative frequencies, given a frequency distribution.
- 4 Learning how to describe the properties of a data set presented as a histogram or a frequency polygon.
- 5 Learning how to calculate and interpret measures of a central tendency, including the population mean, sample mean, arithmetic mean, weighted average or mean, geometric mean, harmonic mean median, and mode.
- 6 Learning how to calculate and interpret quartiles, quintiles, deciles, and percentiles.
- 7 Learning how to calculate and interpret 1) a range and a mean absolute deviation and 2) the variance and standard deviation of a population and of a sample.
- 8 Learning how to calculate and interpret the proportion of observations falling within a specified number of standard deviations of the mean using Chebyshev's inequality.
- 9 Learning how to calculate and interpret the coefficient of variation and the Sharpe ratio.
- 10 Learning how to explain skewness and the meaning of a positively or negatively skewed return distribution.
- 11 Learning how to describe the relative of the mean, median, and mode for a unimodal, nonsymmetrical distribution.

- 12 Learning how to explain measures of sample skewness and kurtosis.
- 13 Learning how to compare the use of arithmetic and geometric means when analyzing investment returns.

Module 4: Probability Concepts

- 1 Learning how to define a random variable, an outcome, an event, mutually exclusive events, and exhaustive events.
- 2 Learning how to state the two defining properties of probability and distinguish among empirical, subjective, and a priori probabilities.
- 3 Learning how to state the probability of an event in terms of odds for and against the event.
- 4 Learning how to distinguish between unconditional and conditional probabilities.
- 5 Learning how to explain the multiplication, addition, and total probability rules.
- 6 Learning how to calculate and interpret 1) the joint probability of two events, 2) the probability that at least one of the two events will occur, given the probability of each and the joint probability of the two events, and 3) a joint probability of any number of independent events.
- 7 Learning how to distinguish between dependent and independent events.
- 8 Learning how to calculate and interpret an unconditional probability using the total probability rule.
- 9 Learning how to explain the use of conditional expectation in investment applications.
- 10 Learning how to explain the use of a tree diagram to represent an investment problem.
- 11 Learning how to calculate and interpret covariance and correlation.

- 12 Learning how to calculate and interpret the expected value, variance, and standard deviation of a random variable and of returns on a portfolio.
- 13 Learning how to calculate and interpret covariance given a joint probability function.
- 14 Learning how to calculate and interpret an updated probability using Bayes' formula.
- 15 Learning how to identify the most appropriate method to solve a particular counting problem and solve counting problems using factorial, combination, and permutation concepts.

Module 5: Common Probability Distributions

- 1 Learning how to define a probability distribution and distinguish between discrete and continuous random variables and their probability functions.
- 2 Learning how to describe the set of possible outcomes of a specified discrete random variable.
- 3 Learning how to interpret a cumulative distribution function.
- 4 Learning how to calculate and interpret probabilities for a random variable, given its cumulative distribution function.
- 5 Learning how to define a discrete uniform random variable, a Bernoulli random variable, and a binomial random variable.
- 6 Learning how to calculate and interpret probabilities given the discrete uniform and binomial distribution functions.
- 7 Learning how to construct a binomial tree to describe stock price movement.
- 8 Learning how to calculate and interpret tracking error.
- 9 Learning how to define the continuous uniform distribution and calculate and interpret probabilities, given a continuous uniform distribution.
- 10 Learning how to explain the key properties of the normal distribution.
- 11 Learning how to distinguish between a univariate and a multivariate distribution, and explain the role of correlation in the multivariate normal distribution.

- 12 Learning how to determine the probability that a normally distributed random variable lies inside a given interval.
- 13 Learning how to define the standard normal distribution, explain how to standardize a random variable, and calculate and interpret probabilities using the standard normal distribution.
- 14 Learning how to define shortfall risk, calculate the safety-first ratio, and select an optimal portfolio using Roy's safety-first criterion.
- 15 Learning how to explain the relationship between normal and lognormal distributions and why the lognormal distribution is used to model asset prices.
- 16 Learning how to distinguish between discretely and continuously compounded rates of return, and calculate and interpret a continuously compounded rate of return, given a specific holding period return.
- 17 Learning how to explain Monte Carlo simulation and describe its major applications and limitations.
- 18 Learning how to compare Monte Carlo simulation and historical simulation.

Module 6: Sampling and Estimation

- 1 Learning how to define simple random sampling and a sampling distribution.
- 2 Learning how to explain sampling error.
- 3 Learning how to distinguish between simple random and stratified random sampling.
- 4 Learning how to distinguish between time-series and cross-sectional data.
- 5 Learning how to explain the central limit theorem and its importance.
- 6 Learning how to calculate and interpret the standard error of the sample mean.
- 7 Learning how to identify and describe desirable properties of an estimator.
- 8 Learning how to distinguish between a point estimate and a confidence interval estimate of a population parameter.

- 9 Learning how to describe properties of Student's t-distribution and calculate and interpret its degrees of freedom.
- 10 Learning how to calculate and interpret a confidence interval for a population mean, given a normal distribution with 1) a known population variance, 2) an unknown population variance, or 3) an unknown variance and a large sample size.
- 11 Learning how to describe the issues regarding selection of the appropriate sample size, data-mining bias, sample selection bias, survivorship bias, look-ahead bias, and time-period bias.

Module 7: Hypothesis Testing

- 1 Learning how to define a hypothesis, describe the steps of hypothesis testing, and describe and interpret the choice of the null and alternative hypothesis; and to distinguish between one-tailed and two-tailed tests of hypotheses.
- 2 Learning how to explain a test statistic, Type I and Type II errors, a significance level, and how significance levels are used in hypothesis testing.
- 3 Learning how to explain a decision rule, the power of a test, and the relation between confidence intervals and hypothesis tests.
- 4 Learning how to distinguish between a statistical result and an economically meaningful result.
- 5 Learning how to explain and interpret the p-value as it relates to hypothesis testing.
- 6 Learning how to identify the appropriate test statistic and interpret the results for a hypothesis test concerning the population mean of both large and small samples when the population is normally or approximately distributed and the variance is 1) known or 2) unknown.
- 7 Learning how to identify the appropriate test statistic and interpret the results for a hypothesis test concerning the equality of the population means of two at least approximately normally distributed populations, based on independent random samples with 1) equal or 2) unequal assumed variances.

- 8 Learning how to identify the appropriate test statistic and interpret the results for a hypothesis test concerning the mean difference of two normally distributed populations.
- 9 Learning how to identify the appropriate test statistic and interpret the results for a hypothesis test concerning 1) the variance of a normally distributed population, and 2) the equality of the variances of two normally distributed populations based on two independent random samples.
- 10 Learning how to distinguish between parametric and nonparametric tests and describe situations in which the use of nonparametric tests may be appropriate.

Module 8: Technical Analysis

- 1 Learning how to explain principles of technical analysis, its applications, and its underlying assumptions.
- 2 Learning how to describe the construction of different types of technical analysis charts and interpret them.
- 3 Learning how to explain uses of trend, support, resistance lines, and change in polarity.
- 4 Learning how to describe common chart patterns.
- 5 Learning how to describe common technical analysis indicators (price-based, momentum oscillators, sentiment, and flow of funds).
- 6 Learning how to explain how technical analysts use cycles.
- 7 Learning how to describe the key tenets of Elliott Wave Theory and the importance of Fibonacci numbers.
- 8 Learning how to describe intermarket analysis as it relates to technical analysis and asset allocation.