STUDY SESSION

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Quantitative Methods (2)

This study session introduces the common probability distributions used to describe the behavior of random variables, such as asset prices and returns. How to estimate measures of a population (mean, standard deviation) based on a population sample is shown. The study session provides a framework for hypothesis testing, used for validating dataset hypotheses, along with techniques to test a hypothesis. Finally, simple linear regression is presented as a method for understanding the relationship between two variables as a way of making predictions.

READING ASSIGNMENTS

Reading 4	Common Probability Distributions by Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA
Reading 5	Sampling and Estimation by Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA
Reading 6	Hypothesis Testing by Pamela Peterson Drake, PhD, CFA
Reading 7	Introduction to Linear Regression by Pamela Peterson Drake, PhD, CFA

LEARNING OUTCOMES

READING 4. COMMON PROBABILITY DISTRIBUTIONS

The candidate should be able to:

a define a probability distribution and compare and contrast discrete and continuous random variables and their probability functions;

b calculate and interpret probabilities for a random variable given its cumulative distribution function;

c describe the properties of a discrete uniform random variable, and calculate and interpret probabilities given the discrete uniform distribution function;

d describe the properties of the continuous uniform distribution, and calculate and interpret probabilities given a continuous uniform distribution;

e describe the properties of a Bernoulli random variable and a binomial random variable, and calculate and interpret probabilities given the binomial distribution function;

f explain the key properties of the normal distribution;

g contrast a multivariate distribution and a univariate distribution, and explain the role of correlation in the multivariate normal distribution;

h calculate the probability that a normally distributed random variable lies inside a given interval;

i explain how to standardize a random variable;

j calculate and interpret probabilities using the standard normal distribution;

k define shortfall risk, calculate the safety-first ratio, and identify an optimal portfolio using Roy's safety-first criterion;

l explain the relationship between normal and lognormal distributions and why the lognormal distribution is used to model asset prices;

m calculate and interpret a continuously compounded rate of return, given a specific holding period return;

n describe the properties of the Student's *t*-distribution, and calculate and interpret its degrees of freedom;

o describe the properties of the chi-square distribution and the *F*-distribution, and calculate and interpret their degrees of freedom;

p describe Monte Carlo simulation.

READING 5. SAMPLING AND ESTIMATION

The candidate should be able to:

a compare and contrast probability samples with non-probability samples and discuss applications of each to an investment problem;

b explain sampling error;

c compare and contrast simple random, stratified random, cluster, convenience, and judgmental sampling;

d explain the central limit theorem and its importance;

e calculate and interpret the standard error of the sample mean;

f identify and describe desirable properties of an estimator;

g contrast a point estimate and a confidence interval estimate of a population parameter;

h 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 population variance and a large sample size;

i describe the use of resampling (bootstrap, jackknife) to estimate the sampling distribution of a statistic.

j describe the issues regarding selection of the appropriate sample size, data snooping bias, sample selection bias, survivorship bias, look-ahead bias, and time-period bias.

READING 6. HYPOTHESIS TESTING

The candidate should be able to:

a define a hypothesis, describe the steps of hypothesis testing, and describe and interpret the choice of the null and alternative hypotheses;

b compare and contrast one-tailed and two-tailed tests of hypotheses;

c explain a test statistic, Type I and Type II errors, a significance level, how significance levels are used in hypothesis testing, and the power of a test;

d explain a decision rule and the relation between confidence intervals and hypothesis tests, and determine whether a statistically significant result is also economically meaningful.

e explain and interpret the *p*-value as it relates to hypothesis testing;

f describe how to interpret the significance of a test in the context of multiple tests;

g 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 normally distributed and the variance is (1) known or (2) unknown;

h 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 equal assumed variances;

i identify the appropriate test statistic and interpret the results for a hypothesis test concerning the mean difference of two normally distributed populations;

j 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;

k compare and contrast parametric and nonparametric tests, and describe situations where each is the more appropriate type of test;

l 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;

m explain tests of independence based on contingency table data.

READING 7. INTRODUCTION TO LINEAR REGRESSION

The candidate should be able to:

a describe a simple linear regression model and the roles of the dependent and independent variables in the model;

b describe the least squares criterion, how it is used to estimate regression coefficients, and their interpretation;

c explain the assumptions underlying the simple linear regression model, and describe how residuals and residual plots indicate if these assumptions may have been violated;

d calculate and interpret the coefficient of determination and the *F*-statistic in a simple linear regression;

e 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;

f formulate a null and an alternative hypothesis about a population value of a regression coefficient, and determine whether the null hypothesis is rejected at a given level of significance;

g 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;

h describe different functional forms of simple linear regressions.