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 ends with a framework for hypothesis testing, used for validating dataset hypotheses, along with techniques to test a hypothesis.

READING ASSIGNMENTS

Reading 9	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 10	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 11	Hypothesis Testing by Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA

LEARNING OUTCOMES

READING 9. COMMON PROBABILITY DISTRIBUTIONS

The candidate should be able to:

a define a probability distribution and distinguish between discrete and continuous random variables and their probability functions;

b describe the set of possible outcomes of a specified discrete random variable;

c interpret a cumulative distribution function;

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

e define a discrete uniform random variable, a Bernoulli random variable, and a binomial random variable;

f calculate and interpret probabilities given the discrete uniform and the binomial distribution functions;

g construct a binomial tree to describe stock price movement;

h define the continuous uniform distribution and calculate and interpret probabilities, given a continuous uniform distribution;

i explain the key properties of the normal distribution;

j distinguish between a univariate and a multivariate distribution and explain the role of correlation in the multivariate normal distribution;

k determine the probability that a normally distributed random variable lies inside a given interval;

l define the standard normal distribution, explain how to standardize a random variable, and calculate and interpret probabilities using the standard normal distribution;

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

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

o 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;

p explain Monte Carlo simulation and describe its applications and limitations;

q compare Monte Carlo simulation and historical simulation.

READING 10. SAMPLING AND ESTIMATION

The candidate should be able to:

a define simple random sampling and a sampling distribution;

b explain sampling error;

c distinguish between simple random and stratified random sampling;

d distinguish between time-series and cross-sectional data;

e explain the central limit theorem and its importance;

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

g identify and describe desirable properties of an estimator;

h distinguish between a point estimate and a confidence interval estimate of a population parameter;

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

j 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;

k 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.

READING 11. 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 distinguish between one-tailed and two-tailed tests of hypotheses;

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

d explain a decision rule, the power of a test, and the relation between confidence intervals and hypothesis tests;

e distinguish between a statistical result and an economically meaningful result;

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

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 1) equal or 2) unequal 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 formulate a test of the hypothesis that the population correlation coefficient equals zero and determine whether the hypothesis is rejected at a given level of significance;

l distinguish between parametric and nonparametric tests and describe situations in which the use of nonparametric tests may be appropriate.