STUDY SESSION

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Quantitative Methods (1)

This study session provides coverage on how linear regression and time-series analysis are used as tools in financial analysis for identifying relationships among variables. The session begins by examining simple linear regression with a single (independent) variable to explain or predict the value of another (dependent) variable. Multiple regression, using more than one independent variable to explain or predict a dependent variable, is explored next. Time-series analysis, in which the dependent variable's past values are included as independent variables, concludes the session.

READING ASSIGNMENTS

Reading 1	Introduction to Linear Regression by Pamela Peterson Drake, PhD, CFA
Reading 2	Multiple Regression by Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA
Reading 3	Time-Series Analysis 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 1. 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.

READING 2. MULTIPLE REGRESSION

The candidate should be able to:

a formulate a multiple regression equation to describe the relation between a dependent variable and several independent variables, and determine the statistical significance of each independent variable;

b interpret estimated regression coefficients and their *p*-values;

c formulate a null and an alternative hypothesis about the population value of a regression coefficient, calculate the value of the test statistic, and determine whether to reject the null hypothesis at a given level of significance;

d interpret the results of hypothesis tests of regression coefficients;

e calculate and interpret a predicted value for the dependent variable, given an estimated regression model and assumed values for the independent variables;

f explain the assumptions of a multiple regression model;

g calculate and interpret the *F*-statistic, and describe how it is used in regression analysis;

h contrast and interpret the R2 and adjusted R2 in multiple regression;

i evaluate how well a regression model explains the dependent variable by analyzing the output of the regression equation and an ANOVA table;

j formulate and interpret a multiple regression, including qualitative independent variables;

k explain the types of heteroskedasticity and how heteroskedasticity and serial correlation affect statistical inference;

l describe multicollinearity, and explain its causes and effects in regression analysis;

m describe how model misspecification affects the results of a regression analysis, and describe how to avoid common forms of misspecification;

n interpret an estimated logistic regression;

o evaluate and interpret a multiple regression model and its results.

READING 3. TIME-SERIES ANALYSIS

The candidate should be able to:

a calculate and evaluate the predicted trend value for a time series, modeled as either a linear trend or a log-linear trend, given the estimated trend coefficients;

b describe factors that determine whether a linear or a log-linear trend should be used with a particular time series and evaluate limitations of trend models;

c explain the requirement for a time series to be covariance stationary and describe the significance of a series that is not stationary;

d describe the structure of an autoregressive (AR) model of order p and calculate one- and two-period-ahead forecasts given the estimated coefficients;

e explain how autocorrelations of the residuals can be used to test whether the autoregressive model fits the time series;

f explain mean reversion and calculate a mean-reverting level;

g contrast in-sample and out-of-sample forecasts and compare the forecasting accuracy of different time-series models based on the root mean squared error criterion;

h explain the instability of coefficients of time-series models;

i describe characteristics of random walk processes and contrast them to covariance stationary processes;

j describe implications of unit roots for time-series analysis, explain when unit roots are likely to occur and how to test for them, and demonstrate how a time series with a unit root can be transformed so it can be analyzed with an AR model;

k describe the steps of the unit root test for nonstationarity and explain the relation of the test to autoregressive time-series models;

l explain how to test and correct for seasonality in a time-series model and calculate and interpret a forecasted value using an AR model with a seasonal lag;

m explain autoregressive conditional heteroskedasticity (ARCH) and describe how ARCH models can be applied to predict the variance of a time series;

n explain how time-series variables should be analyzed for nonstationarity and/or cointegration before use in a linear regression; and

o determine an appropriate time-series model to analyze a given investment problem and justify that choice.