

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

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| 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 R^2 and adjusted R^2 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.