




2023 CFA[®]
Exam Prep

SchweserNotes[™]
Quantitative Methods and Economics



LEVEL II BOOK 1

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Level II CFA® Exam

CFA®

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Our core product, the SchweserNotes™, addresses all of the Topics, Readings, and LOS in the CFA curriculum. Each reading in the SchweserNotes has been broken into smaller, bite-sized modules with Module Quizzes interspersed throughout to help you continually assess your comprehension. After you complete each Topic, take our online Topic Quiz to help you assess your knowledge of the material before you move on to the next section.

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Again, thank you for trusting Kaplan Schweser with your CFA exam preparation. We're here to help you throughout your journey to become a CFA charterholder.

Regards,



Derek Burkett, CFA, FRM, CAIA
Vice President (Advanced Designations)

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Book 1: Quantitative Methods and Economics

SchweserNotes™ 2023

Level II CFA®

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LEARNING OUTCOME STATEMENTS (LOS)

1. Multiple Regression

The candidate should be able to:

- a. describe the types of investment problems addressed by multiple linear regression and the regression process.
- b. formulate a multiple linear regression model, describe the relation between the dependent variable and several independent variables, and interpret estimated regression coefficients.
- c. explain the assumptions underlying a multiple linear regression model and interpret residual plots indicating potential violations of these assumptions.
- d. evaluate how well a multiple regression model explains the dependent variable by analyzing ANOVA table results and measures of goodness of fit.
- e. formulate hypotheses on the significance of two or more coefficients in a multiple regression model and interpret the results of the joint hypothesis tests.
- f. calculate and interpret a predicted value for the dependent variable, given the estimated regression model and assumed values for the independent variable.
- g. describe how model misspecification affects the results of a regression analysis and how to avoid common forms of misspecification.
- h. explain the types of heteroskedasticity and how it affects statistical inference.
- i. explain serial correlation and how it affects statistical inference.
- j. explain multicollinearity and how it affects regression analysis.
- k. describe influence analysis and methods of detecting influential data points.
- l. formulate and interpret a multiple regression model that includes qualitative independent variables.
- m. formulate and interpret a logistic regression model.

2. 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.

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

3. Machine Learning

The candidate should be able to:

- a. describe supervised machine learning, unsupervised machine learning, and deep learning.
- b. describe overfitting and identify methods of addressing it.
- c. describe supervised machine learning algorithms—including penalized regression, support vector machine, k-nearest neighbor, classification and regression tree, ensemble learning, and random forest—and determine the problems for which they are best suited.
- d. describe unsupervised machine learning algorithms—including principal components analysis, k-means clustering, and hierarchical clustering—and determine the problems for which they are best suited.
- e. describe neural networks, deep learning nets, and reinforcement learning.

4. Big Data Projects

The candidate should be able to:

- a. identify and explain steps in a data analysis project.
- b. describe objectives, steps, and examples of preparing and wrangling data.
- c. evaluate the fit of a machine learning algorithm.
- d. describe objectives, methods, and examples of data exploration.
- e. describe methods for extracting, selecting and engineering features from textual data.
- f. describe objectives, steps, and techniques in model training.
- g. describe preparing, wrangling, and exploring text-based data for financial forecasting.

5. Currency Exchange Rates: Understanding Equilibrium Value

The candidate should be able to:

- a. calculate and interpret the bid–offer spread on a spot or forward currency quotation and describe the factors that affect the bid–offer spread.
- b. identify a triangular arbitrage opportunity and calculate its profit, given the bid–offer quotations for three currencies.
- c. explain spot and forward rates and calculate the forward premium/discount for a given currency.
- d. calculate the mark-to-market value of a forward contract.
- e. explain international parity conditions (covered and uncovered interest rate parity, forward rate parity, purchasing power parity, and the international Fisher effect).
- f. describe relations among the international parity conditions.
- g. evaluate the use of the current spot rate, the forward rate, purchasing power parity, and uncovered interest parity to forecast future spot exchange rates.
- h. explain approaches to assessing the long-run fair value of an exchange rate.
- i. describe the carry trade and its relation to uncovered interest rate parity and calculate the profit from a carry trade.
- j. explain how flows in the balance of payment accounts affect currency exchange rates.
- k. explain the potential effects of monetary and fiscal policy on exchange rates.
- l. describe objectives of central bank or government intervention and capital controls and describe the effectiveness of intervention and capital controls.
- m. describe warning signs of a currency crisis.

6. Economic Growth

The candidate should be able to:

- a. compare factors favoring and limiting economic growth in developed and developing economies.
- b. describe the relation between the long-run rate of stock market appreciation and the sustainable growth rate of the economy.
- c. explain why potential GDP and its growth rate matter for equity and fixed income investors.
- d. contrast capital deepening investment and technological progress and explain how each affects economic growth and labor productivity.
- e. demonstrate forecasting potential GDP based on growth accounting relations.
- f. explain how natural resources affect economic growth and evaluate the argument that limited availability of natural resources constrains economic growth.

- g. explain how demographics, immigration, and labor force participation affect the rate and sustainability of economic growth.
- h. explain how investment in physical capital, human capital, and technological development affects economic growth.
- i. compare classical growth theory, neoclassical growth theory, and endogenous growth theory.
- j. explain and evaluate convergence hypotheses.
- k. describe the economic rationale for governments to provide incentives to private investment in technology and knowledge.
- l. describe the expected impact of removing trade barriers on capital investment and profits, employment and wages, and growth in the economies involved.

7. Economics of Regulation

The candidate should be able to:

- a. describe the economic rationale for regulatory intervention.
- b. explain the purposes of regulating commerce and financial markets.
- c. describe anticompetitive behaviors targeted by antitrust laws globally and evaluate the antitrust risk associated with a given business strategy.
- d. describe classifications of regulations and regulators.
- e. describe uses of self-regulation in financial markets.
- f. describe regulatory interdependencies and their effects.
- g. describe tools of regulatory intervention in markets.
- h. describe benefits and costs of regulation.
- i. describe the considerations when evaluating the effects of regulation on an industry.

WELCOME TO THE 2023 LEVEL II SCHWESERNOTES™

Thank you for trusting Kaplan Schweser to help you reach your goals. We are pleased that you have chosen us to assist you in preparing for the Level II CFA Exam. In this introduction, I want to explain the resources included with these SchweserNotes, suggest how you can best use Schweser materials to prepare, and direct you towards other educational resources you will find helpful as you study for the exam.

Besides the SchweserNotes themselves, there are many educational resources available at Schweser.com. Log in using the individual username and password that you received when you purchased your SchweserNotes.

SchweserNotes™

These notes consist of five volumes that include complete coverage of all 10 Topic areas and all 413 Learning Outcome Statements (LOS). Examples and Module Quizzes (multiple-choice questions) are provided along the way to help you master the material and check your progress. At the end of each major topic area, you can take an online Topic Quiz for that subject. Topic Quiz questions are created to be exam-like in format and difficulty, to help you evaluate how well your study of each topic has prepared you for the actual exam.

Practice Questions

Studies have shown that to retain what you learn, it is essential that you quiz yourself often. For this purpose we offer SchweserPro™ QBank, which contains thousands of Level II practice questions and explanations. Questions are available for each module and topic. Build your own quizzes by specifying the topics and the number of questions. SchweserPro™ QBank is an important learning aid for achieving the depth of proficiency needed at Level II. It should not, however, be considered a replacement for rehearsing with “exam-type” questions as found in our Schweser Mock Exams.

Mock Exams

Schweser offers six full-length mock exams: Schweser Mock Exams 1 through 6 each contain complete 88-question tests, with answer explanations. These are important tools for gaining the speed and skills you will need to pass the exam. You can use our Performance Tracker to monitor how you are performing compared to other Schweser Level II candidates.

How to Succeed

The Level II CFA exam is a formidable challenge (44 readings and 413 Learning Outcome Statements), so you must devote considerable time and effort to be adequately prepared. There is no shortcut! You must learn the material, know the terminology and techniques, understand the concepts, and be able to answer 88 questions quickly and

mostly-correctly. Fifteen hours per week for 25 weeks is a useful estimate of the study time required on average, but different candidates will need more or less time, depending on their individual backgrounds and experience.

There is no way around it; CFA Institute will test you in a way that will reveal how well you know the Level II curriculum. You should begin early and stick to your study plan. Read the SchweserNotes and complete the Module Quizzes. Prepare for and attend a live class, an online class, or a study group each week. Take quizzes often using SchweserPro QBank, and go back to review previous topics regularly. At the end of each topic area, take the online Topic Quiz to check your progress. You should try to finish reading the curriculum at least four weeks before the Level II exam so that you have sufficient time for Mock Exams and for further review of those topics that you have not yet mastered.

I would like to thank Kent Westlund, CFA Content Specialist, for his contributions to the 2023 Level II SchweserNotes for the CFA Exam.

Best regards,

A handwritten signature in cursive script that reads "Bijesh Tolia".

Dr. Bijesh Tolia, CFA, CA

VP of CFA Education and Level II Manager

Kaplan Schweser

READING 1

MULTIPLE REGRESSION

EXAM FOCUS

Multiple linear regression models explain the variation in a dependent variable using more than one independent variables. You should know how to use an F -test to test the effectiveness of nested models. Become familiar with the effects that heteroskedasticity, serial correlation, and multicollinearity have on regression results, and be able to identify common model misspecifications. Finally, understand the role of influential observations in the estimated model, and the use of logistic regression models.

MODULE 1.1: BASICS OF MULTIPLE REGRESSION AND UNDERLYING ASSUMPTIONS



Video covering this content is available online.

LOS 1.a: Describe the types of investment problems addressed by multiple linear regression and the regression process.

Given the complexities of financial and economic relations, a simple one-factor linear regression model is usually inadequate. **Multiple regression** models allow for consideration of multiple underlying influences (independent variables) on the dependent variable.

We can use multiple regression models to:

1. **Identify relationships between variables:** For example, an analyst may perform exploratory analysis of the factors that influence returns on small-cap stocks. Or, the analyst may wish to determine if the three-factor Fama-French model (market, size, and style) actually adequately explains cross-sectional returns for a sample time period.
2. **Forecast variables:** For example, an analyst may seek to forecast cash flows for a company, or to predict the probability of company default.
3. **Test existing theories:** For example, analysts may want to assess if corporate debt issuers with high levels of intangibles on their balance sheet (in addition to other known factors) explain credit risk premiums for those issuers.

Warm-Up: Multiple Regression Basics

The general multiple linear regression model is:

$$Y_i = b_0 + b_1X_{1i} + b_2X_{2i} + \dots + b_kX_{ki} + \varepsilon_i$$

where:

Y_i = i th observation of the dependent variable Y , $i = 1, 2, \dots, n$

X_j = independent variables, $j = 1, 2, \dots, k$

X_{ji} = i th observation of the j th independent variable

b_0 = intercept term

b_j = slope coefficient for each of the independent variables

ε_i = error term for the i th observation

n = number of observations

k = number of independent variables

The multiple regression methodology estimates the intercept and slope coefficients such that the sum of the squared error terms, $\sum_{i=1}^n \varepsilon_i^2$, is minimized. The result of this process is the following regression equation:

$$\hat{Y}_i = \hat{b}_0 + \hat{b}_1X_{1i} + \hat{b}_2X_{2i} + \dots + \hat{b}_kX_{ki}$$

where the “^” indicates an estimate for the corresponding regression coefficient

The **residual**, $\hat{\varepsilon}_i$, is the difference between the observed value, Y_i , and the predicted value from the regression, \hat{Y}_i :

$$\hat{\varepsilon}_i = Y_i - \hat{Y}_i = Y_i - (\hat{b}_0 + \hat{b}_1X_{1i} + \hat{b}_2X_{2i} + \dots + \hat{b}_kX_{ki})$$

The Level I curriculum covered simple linear regression and the t-test for statistical significance of the slope coefficient. For Level II, in order to interpret regression results, we can alternatively use the **p-value** to evaluate the null hypothesis that a slope coefficient is equal to zero.

The p -value is the smallest level of significance for which the null hypothesis can be rejected. We test the significance of coefficients by comparing the p -value to the chosen significance level:

- If the p -value is less than the significance level, the null hypothesis can be rejected.
- If the p -value is greater than the significance level, the null hypothesis cannot be rejected.

LOS 1.b: Formulate a multiple linear regression model, describe the relation between the dependent variable and several independent variables, and interpret estimated regression coefficients.

Let's illustrate multiple regression using research by Arnott and Asness (2003)¹ As part of their research, the authors tested the hypothesis that future 10-year real earnings growth in the S&P 500 (EG10) can be explained by the trailing dividend payout ratio of the stocks in the index (PR) and the yield curve slope (YCS). YCS is calculated as the difference between the 10-year T-bond yield and the 3-month T-bill yield at the start of the period. All three variables are measured in percent.

Formulating the Multiple Regression Equation

The authors formulated the following regression equation using annual data (46 observations):

$$EG10 = b_0 + b_1PR + b_2YCS + \varepsilon$$

The results of this regression are shown in Figure 1.1.

Figure 1.1: Coefficient and Standard Error Estimates for Regression of EG10 on PR and YCS

	Coefficient	Standard Error
Intercept	-11.6%	1.657%
PR	0.25	0.032
YCS	0.14	0.280

Interpreting the Multiple Regression Results

The interpretation of the estimated regression coefficients from a multiple regression is the same as in simple linear regression for the intercept term, but somewhat different for the slope coefficients:

- The **intercept term** is the value of the dependent variable when the independent variables are all equal to zero.
- Each slope coefficient is the estimated change in the dependent variable for a 1-unit change in that independent variable, *holding the other independent variables constant*. For this reason, the slope coefficients in a multiple regression are sometimes called **partial slope coefficients**.

For example, regarding the real earnings growth model, we can make these interpretations:

- *Intercept term*: If the dividend payout ratio is zero and the slope of the yield curve is zero, we would expect the subsequent 10-year real earnings growth rate to be -11.6%.
- *PR coefficient*: If the payout ratio increases by 1%, we would expect the subsequent 10-year earnings growth rate to increase by 0.25%, *holding YCS constant*.
- *YCS coefficient*: If the yield curve slope increases by 1%, we would expect the subsequent 10-year earnings growth rate to increase by 0.14%, *holding PR constant*.

Let's discuss the interpretation of the multiple regression slope coefficients in more detail. Suppose we run a regression of the dependent variable Y on a single independent variable X_1 and get the following result:

$$Y = 2.0 + 4.5 X_1$$

The appropriate interpretation of the estimated slope coefficient is that if X_1 increases by 1 unit, we would expect Y to increase by 4.5 units.

Now suppose we add a second independent variable X_2 to the regression and get the following result:

$$Y = 1.0 + 2.5 X_1 + 6.0 X_2$$

Notice that the estimated slope coefficient for X_1 changed from 4.5 to 2.5 when we added X_2 to the regression. We expect this to happen when a second variable is included.

Now the interpretation of the estimated slope coefficient for X_1 is that if X_1 increases by 1 unit, we would expect Y to increase by 2.5 units, *holding X_2 constant*.

LOS 1.c: Explain the assumptions underlying a multiple linear regression model and interpret residual plots indicating potential violations of these assumptions.

Assumptions underlying a multiple regression model include:

- A linear relationship exists between the dependent and independent variables.
- The residuals are normally distributed.
- The variance of the error terms is constant for all observations.
- The residual for one observation is not correlated with that of another observation.
- The independent variables are not random, and there is no exact linear relation between any two or more independent variables.

Residual plots allow analysts to get a preliminary indication of violation of regression assumptions. We will discuss formal statistical tests for the detection of violation of (the last three) regression assumptions later.

EXAMPLE: Office rent model

An analyst wants to model the determinants of rents for office properties in a large city in the United States. Using a sample of 191 observations, she has estimated the following model:

$$\text{rent}_i = b_0 + b_1 \text{age}_i + b_2 \text{distance}_i + b_3 \text{restaurant}_i + \varepsilon_i$$

where:

rent = monthly rent per square feet (\$)

age = age of the property (in years)

distance = distance from the nearest metro station (in miles)

restaurant = number of lunch locations within walking distance

Regression Output:

Coefficients	Estimate	Std. Error
(Intercept)	44.67	2.01
Age	-0.31	0.05
Distance	-0.01	0.001
Restaurant	1.29	0.29

Exhibit 1: Plot of Residual vs. Predicted Values