
CONTENTS

Foreword	xiii
Acknowledgments	xvii
Introduction	xix
CHAPTER 1	
The Time Value of Money	1
1 Introduction	1
2 Interest Rates: Interpretation	1
3 The Future Value of a Single Cash Flow	3
3.1 The Frequency of Compounding	8
3.2 Continuous Compounding	10
3.3 Stated and Effective Rates	12
4 The Future Value of a Series of Cash Flows	13
4.1 Equal Cash Flows—Ordinary Annuity	13
4.2 Unequal Cash Flows	15
5 The Present Value of a Single Cash Flow	15
5.1 Finding the Present Value of a Single Cash Flow	15
5.2 The Frequency of Compounding	17
6 The Present Value of a Series of Cash Flows	19
6.1 The Present Value of a Series of Equal Cash Flows	19
6.2 The Present Value of an Infinite Series of Equal Cash Flows—Perpetuity	23
6.3 Present Values Indexed at Times Other Than $t = 0$	24
6.4 The Present Value of a Series of Unequal Cash Flows	26
7 Solving for Rates, Number of Periods, or Size of Annuity Payments	27
7.1 Solving for Interest Rates and Growth Rates	27
7.2 Solving for the Number of Periods	30
7.3 Solving for the Size of Annuity Payments	30
7.4 Review of Present and Future Value Equivalence	35
7.5 The Cash Flow Additivity Principle	36

CHAPTER 2	
Discounted Cash Flow Applications	39
1 Introduction	39
2 Net Present Value and Internal Rate of Return	39
2.1 Net Present Value and the Net Present Value Rule	40
2.2 The Internal Rate of Return and the Internal Rate of Return Rule	42
2.3 Problems with the IRR Rule	45
3 Portfolio Return Measurement	47
3.1 Money-Weighted Rate of Return	47
3.2 Time-Weighted Rate of Return	49
4 Money Market Yields	54
CHAPTER 3	
Statistical Concepts and Market Returns	61
1 Introduction	61
2 Some Fundamental Concepts	61
2.1 The Nature of Statistics	62
2.2 Populations and Samples	62
2.3 Measurement Scales	63
3 Summarizing Data Using Frequency Distributions	65
4 The Graphic Presentation of Data	72
4.1 The Histogram	73
4.2 The Frequency Polygon and the Cumulative Frequency Distribution	74
5 Measures of Central Tendency	76
5.1 The Arithmetic Mean	77
5.2 The Median	81
5.3 The Mode	84
5.4 Other Concepts of Mean	85
6 Other Measures of Location: Quantiles	94
6.1 Quartiles, Quintiles, Deciles, and Percentiles	94
6.2 Quantiles in Investment Practice	98
7 Measures of Dispersion	100
7.1 The Range	100
7.2 The Mean Absolute Deviation	101
7.3 Population Variance and Population Standard Deviation	103
7.4 Sample Variance and Sample Standard Deviation	106
7.5 Semivariance, Semideviation, and Related Concepts	110
7.6 Chebyshev's Inequality	111
7.7 Coefficient of Variation	113
7.8 The Sharpe Ratio	115
8 Symmetry and Skewness in Return Distributions	118
9 Kurtosis in Return Distributions	123
10 Using Geometric and Arithmetic Means	127

CHAPTER 4	
Probability Concepts	129
1 Introduction	129
2 Probability, Expected Value, and Variance	129
3 Portfolio Expected Return and Variance of Return	152
4 Topics in Probability	161
4.1 Bayes' Formula	161
4.2 Principles of Counting	166
CHAPTER 5	
Common Probability Distributions	171
1 Introduction	171
2 Discrete Random Variables	171
2.1 The Discrete Uniform Distribution	173
2.2 The Binomial Distribution	175
3 Continuous Random Variables	185
3.1 Continuous Uniform Distribution	186
3.2 The Normal Distribution	189
3.3 Applications of the Normal Distribution	197
3.4 The Lognormal Distribution	200
4 Monte Carlo Simulation	206
CHAPTER 6	
Sampling and Estimation	215
1 Introduction	215
2 Sampling	215
2.1 Simple Random Sampling	216
2.2 Stratified Random Sampling	217
2.3 Time-Series and Cross-Sectional Data	219
3 Distribution of the Sample Mean	221
3.1 The Central Limit Theorem	222
4 Point and Interval Estimates of the Population Mean	225
4.1 Point Estimators	225
4.2 Confidence Intervals for the Population Mean	227
4.3 Selection of Sample Size	233
5 More on Sampling	235
5.1 Data-Mining Bias	236
5.2 Sample Selection Bias	238
5.3 Look-Ahead Bias	240
5.4 Time-Period Bias	240
CHAPTER 7	
Hypothesis Testing	243
1 Introduction	243
2 Hypothesis Testing	244

3	Hypothesis Tests Concerning the Mean	253
3.1	Tests Concerning a Single Mean	254
3.2	Tests Concerning Differences between Means	261
3.3	Tests Concerning Mean Differences	265
4	Hypothesis Tests Concerning Variance	269
4.1	Tests Concerning a Single Variance	269
4.2	Tests Concerning the Equality (Inequality) of Two Variances	271
5	Other Issues: Nonparametric Inference	275
5.1	Tests Concerning Correlation: The Spearman Rank Correlation Coefficient	276
5.2	Nonparametric Inference: Summary	279
CHAPTER 8		
Correlation and Regression		281
1	Introduction	281
2	Correlation Analysis	281
2.1	Scatter Plots	281
2.2	Correlation Analysis	282
2.3	Calculating and Interpreting the Correlation Coefficient	283
2.4	Limitations of Correlation Analysis	287
2.5	Uses of Correlation Analysis	289
2.6	Testing the Significance of the Correlation Coefficient	297
3	Linear Regression	300
3.1	Linear Regression with One Independent Variable	300
3.2	Assumptions of the Linear Regression Model	303
3.3	The Standard Error of Estimate	306
3.4	The Coefficient of Determination	309
3.5	Hypothesis Testing	310
3.6	Analysis of Variance in a Regression with One Independent Variable	318
3.7	Prediction Intervals	321
3.8	Limitations of Regression Analysis	324
CHAPTER 9		
Multiple Regression and Issues in Regression Analysis		325
1	Introduction	325
2	Multiple Linear Regression	325
2.1	Assumptions of the Multiple Linear Regression Model	331
2.2	Predicting the Dependent Variable in a Multiple Regression Model	336
2.3	Testing Whether All Population Regression Coefficients Equal Zero	338
2.4	Adjusted R^2	340
3	Using Dummy Variables in Regressions	341
4	Violations of Regression Assumptions	345
4.1	Heteroskedasticity	345
4.2	Serial Correlation	351
4.3	Multicollinearity	356

4.4 Heteroskedasticity, Serial Correlation, Multicollinearity: Summarizing the Issues	359
5 Model Specification and Errors in Specification	359
5.1 Principles of Model Specification	359
5.2 Misspecified Functional Form	360
5.3 Time-Series Misspecification (Independent Variables Correlated with Errors)	368
5.4 Other Types of Time-Series Misspecification	372
6 Models with Qualitative Dependent Variables	372

CHAPTER 10

Time-Series Analysis **375**

1 Introduction	375
2 Challenges of Working with Time Series	375
3 Trend Models	377
3.1 Linear Trend Models	377
3.2 Log-Linear Trend Models	380
3.3 Trend Models and Testing for Correlated Errors	385
4 Autoregressive (AR) Time-Series Models	386
4.1 Covariance-Stationary Series	386
4.2 Detecting Serially Correlated Errors in an Autoregressive Model	387
4.3 Mean Reversion	391
4.4 Multiperiod Forecasts and the Chain Rule of Forecasting	391
4.5 Comparing Forecast Model Performance	394
4.6 Instability of Regression Coefficients	397
5 Random Walks and Unit Roots	399
5.1 Random Walks	400
5.2 The Unit Root Test of Nonstationarity	403
6 Moving-Average Time-Series Models	407
6.1 Smoothing Past Values with an n -Period Moving Average	407
6.2 Moving-Average Time-Series Models for Forecasting	409
7 Seasonality in Time-Series Models	412
8 Autoregressive Moving-Average Models	416
9 Autoregressive Conditional Heteroskedasticity Models	417
10 Regressions with More than One Time Series	420
11 Other Issues in Time Series	424
12 Suggested Steps in Time-Series Forecasting	425

CHAPTER 11

Portfolio Concepts **429**

1 Introduction	429
2 Mean–Variance Analysis	429
2.1 The Minimum-Variance Frontier and Related Concepts	430
2.2 Extension to the Three-Asset Case	439
2.3 Determining the Minimum-Variance Frontier for Many Assets	442
2.4 Diversification and Portfolio Size	445

2.5	Portfolio Choice with a Risk-Free Asset	449
2.6	The Capital Asset Pricing Model	458
2.7	Mean–Variance Portfolio Choice Rules: An Introduction	460
3	Practical Issues in Mean–Variance Analysis	464
3.1	Estimating Inputs for Mean–Variance Optimization	464
3.2	Instability in the Minimum-Variance Frontier	470
4	Multifactor Models	473
4.1	Factors and Types of Multifactor Models	474
4.2	The Structure of Macroeconomic Factor Models	475
4.3	Arbitrage Pricing Theory and the Factor Model	478
4.4	The Structure of Fundamental Factor Models	484
4.5	Multifactor Models in Current Practice	485
4.6	Applications	493
4.7	Concluding Remarks	509
	Appendices	511
	References	521
	Glossary	527
	About the CFA Program	541
	About the Authors	543
	Index	545