

CONTENTS

List of Tables and Figures xv

Preface xxi

Chapter 1 What Is a Regression? 1

1.0	What We Need to Know When We Finish This Chapter	2
1.1	Why Are We Doing This?	3
1.2	Education and Earnings	5
1.3	What Does a Regression Look Like?	6
1.4	Where Do We Begin?	6
1.5	Where's the Explanation?	7
1.6	What Do We Look for in This Explanation?	9
1.7	How Do We Interpret the Explanation?	12
1.8	How Do We Evaluate the Explanation?	17
1.9	R^2 and the F -statistic	19
1.10	Have We Put This Together in a Responsible Way?	20
1.11	Do Regressions Always Look Like This?	25
1.12	How to Read This Book	28
1.13	Conclusion	28
	Exercises	29

Chapter 2 The Essential Tool 35

2.0	What We Need to Know When We Finish This Chapter	35
2.1	Is This Really a Math Course in Disguise?	37
2.2	Fun with Summations	38
2.3	Constants in Summations	41
2.4	Averages	43
2.5	Summations of Sums	44

2.6	More Fun with Summations of Sums	48
2.7	Summations of Products	52
2.8	Time to Reflect	53
	Exercises	54
Chapter 3	Covariance and Correlation	57
3.0	What We Need to Know When We Finish This Chapter	57
3.1	Introduction	58
3.2	The Sample Covariance	60
3.3	Understanding the Sample Covariance	66
3.4	The Sample Correlation	70
3.5	Another Note about Numerical Presentation	78
3.6	Another Example	78
3.7	Conclusion	81
	Appendix to Chapter 3	82
	Exercises	85
Chapter 4	Fitting a Line	88
4.0	What We Need to Know When We Finish This Chapter	88
4.1	Introduction	90
4.2	Which Line Fits Best?	91
4.3	Minimizing the Sum of Squared Errors	95
4.4	Calculating the Intercept and Slope	103
4.5	What, Again, Do the Slope and Intercept Mean?	107
4.6	R^2 and the Fit of This Line	110
4.7	Let's Run a Couple of Regressions	117
4.8	Another Example	120
4.9	Conclusion	122
	Appendix to Chapter 4	123
	Exercises	128
Chapter 5	From Sample to Population	136
5.0	What We Need to Know When We Finish This Chapter	136
5.1	Introduction	138
5.2	The Population Relationship	140
5.3	The Statistical Characteristics of ε_i	143
5.4	The Statistical Characteristics of y_i	149
5.5	Parameters and Estimators	152

5.6	Unbiased Estimators of β and α	153
5.7	Let's Explain This Again	160
5.8	The Population Variances of b and a	165
5.9	The Gauss-Markov Theorem	172
5.10	Consistency	178
5.11	Conclusion	182
	Exercises	183
Chapter 6	Confidence Intervals and Hypothesis Tests	191
6.0	What We Need to Know When We Finish This Chapter	191
6.1	Introduction	193
6.2	The Basis of Confidence Intervals and Hypothesis Tests	194
6.3	Confidence Intervals	198
6.4	Hypothesis Tests	203
6.4.1	Two-Tailed Tests	204
6.4.2	One-Tailed Tests	212
6.4.3	Type I and Type II Errors	216
6.5	The Relationship between Confidence Intervals and Hypothesis Tests	225
	Exercises	227
Chapter 7	Inference in Ordinary Least Squares	232
7.0	What We Need to Know When We Finish This Chapter	232
7.1	The Distributions of b and a	234
7.2	Estimating σ^2	236
7.3	Confidence Intervals for b	241
7.4	Hypothesis Tests for β	251
7.5	Predicting y_i Again	261
7.6	What Can We Say So Far about the Returns to Education?	267
7.7	Another Example	269
7.8	Conclusion	272
	Appendix to Chapter 7	273
	Exercises	276
Chapter 8	What If the Disturbances Have Nonzero Expectations or Different Variances?	281
8.0	What We Need to Know When We Finish This Chapter	281
8.1	Introduction	283

8.2	Suppose the ε_i 's Have a Constant Expected Value That Isn't Zero	284
8.3	Suppose the ε_i 's Have Different Expected Values	288
8.4	Suppose Equation (5.6) Is Wrong	289
8.5	What's the Problem?	290
8.6	σ_i^2 , ε_i^2 , e_i^2 , and the White Test	294
8.7	Fixing the Standard Deviations	299
8.8	Recovering Best Linear Unbiased Estimators	301
8.9	Example: Two Variances for the Disturbances	304
8.10	What If We Have Some Other Form of Heteroscedasticity?	313
8.11	Conclusion	314
	Exercises	315

Chapter 9 What If the Disturbances Are Correlated? 321

9.0	What We Need to Know When We Finish This Chapter	321
9.1	Introduction	323
9.2	Suppose Equation (5.11) Is Wrong	323
9.3	What Are the Consequences of Autocorrelation?	326
9.4	What Is to Be Done?	330
9.5	Autocorrelation, Disturbances, and Shocks	334
9.6	Generalized Least Squares and the Example of First-Order Autocorrelation	342
9.7	Testing for First-Order Autocorrelation	347
9.8	Two-Step Estimation for First-Order Autocorrelation	351
9.9	What If We Have Some Other Form of Autocorrelation?	353
9.10	Conclusion	355
	Exercises	356

Chapter 10 What If the Disturbances and the Explanatory Variables Are Related? 363

10.0	What We Need to Know When We Finish This Chapter	363
10.1	Introduction	366
10.2	How Could This Happen?	366
10.3	What Are the Consequences?	371
10.4	What Can Be Done?	377
10.5	Two-Stage Least Squares and Instrumental Variables	380
10.6	The Properties of Instrumental Variables Estimators	384
10.7	What's a Good Instrument?	389

10.8	How Do We Know If We Have Endogeneity?	395
10.9	What Does This Look Like in Real Data?	397
10.10	Conclusion	401
	Exercises	401
Chapter 11	What If There Is More Than One x?	411
11.0	What We Need to Know When We Finish This Chapter	411
11.1	Introduction	413
11.2	Is There Another Assumption That We Can Violate?	414
11.3	What Shall We Fit This Time?	419
11.4	How Do b_1 and b_2 Really Work?	430
11.5	The Expected Values of b_1 and b_2	438
11.6	Conclusion	446
	Exercises	447
Chapter 12	Understanding and Interpreting Regression with Two x's	453
12.0	What We Need to Know When We Finish This Chapter	453
12.1	Introduction	456
12.2	The Variances of b_1 and b_2	456
12.3	The Interaction between x_{1i} and x_{2i}	463
12.4	Estimated Standard Deviations	468
12.5	Unrestricted and Restricted Regressions	470
12.6	Joint Hypothesis Tests	475
12.7	Wait! What If It's All a Mistake?	484
12.8	What Happens to Chapters 8, 9, and 10 Now?	486
12.9	Conclusion	491
	Exercises	492
Chapter 13	Making Regression More Flexible	501
13.0	What We Need to Know When We Finish This Chapter	501
13.1	Introduction	503
13.2	Dummy Variables	503
13.3	Nonlinear Effects: The Quadratic Specification	507
13.4	Nonlinear Effects: Logarithms	514
13.5	Nonlinear Effects: Interactions	520
13.6	Conclusion	529
	Exercises	530

Chapter 14	More Than Two Explanatory Variables	541
14.0	What We Need to Know When We Finish This Chapter	541
14.1	Introduction	545
14.2	Can We Have More Than Two Explanatory Variables?	545
14.3	Inference in Multivariate Regression	551
14.4	Let's See Some Examples	557
14.5	Assumptions about the Disturbances	568
14.6	Panel Data	569
14.7	Conclusion	573
	Exercises	573
Chapter 15	Categorical Dependent Variables	582
15.0	What We Need to Know When We Finish This Chapter	582
15.1	Introduction	584
15.2	Suppose Income Is Measured Discretely	585
15.3	How Would Parameter Estimates Work?	587
15.4	The Maximum Likelihood Estimator	591
15.5	How Do We Actually Maximize the Likelihood?	596
15.6	What Can We Do with Maximum Likelihood Estimates?	600
15.7	How about Some Examples?	604
15.8	Introduction to Selection Problems	609
15.9	Are There Other Ways to Do This?	613
15.10	Conclusion	615
	Appendix to Chapter 15	615
	Exercises	621
	Epilogue	627
	Appendix	629
	References	637
	Index	639