

# Regression Analysis: Concepts and Applications

**Franklin A. Graybill**

*Colorado State University*

**Hariharan K. Iyer**

*Colorado State University*

# Contents

Preface ix

<b>CHAPTER 1</b>	<b>Review of Basic Statistical Concepts and Matrices</b>	<b>1</b>
1.1	Overview	1
1.2	Basic Ingredients for Statistical Inference	3
1.3	Population	5
1.4	Model	10
1.5	Parameters (Summary Numbers)	14
1.6	Samples and Inferences	20
1.7	Functional Notation	47
1.8	Matrices and Vectors	50
1.9	Multivariate Gaussian Populations	62
1.10	Exercises	70
<b>CHAPTER 2</b>	<b>Regression and Prediction</b>	<b>73</b>
2.1	Overview	73
2.2	Prediction	73
2.3	Regression Analysis	82
2.4	Exercises	97

<b>CHAPTER 3</b>	<b>Straight Line Regression</b>	<b>99</b>
3.1	Overview	99
3.2	An Example of Straight Line Regression	100
3.3	Straight Line Regression Model—Assumptions (A) and (B)	109
3.4	Point Estimation	112
3.5	Checking Assumptions	132
3.6	Confidence Intervals	161
3.7	Tests	171
3.8	Analysis of Variance	178
3.9	Coefficient of Determination and Coefficient of Correlation	181
3.10	Regression Analysis When There Are Measurement Errors	194
3.11	Regression Through the Origin	210
3.12	Exercises	214
<b>CHAPTER 4</b>	<b>Multiple Linear Regression</b>	<b>219</b>
4.1	Overview	219
4.2	Notation and Definitions	220
4.3	Assumptions for Multiple Linear Regression	232
4.4	Point Estimation	235
4.5	Residual Analysis	251
4.6	Confidence Intervals	262
4.7	Tests	278
4.8	Analysis of Variance	283
4.9	Comparison of Two Regression Functions (Nested Case) and Coefficients of Determination	291
4.10	Comparing Two Multiple Regressions Models (Nonnested Case)	309
4.11	Lack-of-Fit Analysis	318
4.12	Exercises	335
<b>CHAPTER 5</b>	<b>Diagnostic Procedures</b>	<b>351</b>
5.1	Overview	351
5.2	Outliers	352

5.3	Leverages or Hat Values	365
5.4	Influential Observations—Cook's Distance and DFFITS	371
5.5	Ill-Conditioning and Multicollinearity	392
5.6	Exercises	399
<b>CHAPTER 6</b>	<b>Applications of Regression I</b>	<b>403</b>
6.1	Overview	403
6.2	Prediction Intervals	403
6.3	Tolerance Intervals	416
6.4	Calibration and Regulation for Straight Line Regression	425
6.5	Comparison of Several Straight Line Regressions—Identical, Parallel, and Intersecting Lines	436
6.6	Intersection of Two Straight Line Regression Functions	450
6.7	Maximum or Minimum of a Quadratic Regression Model	456
6.8	Linear Splines	465
6.9	Exercises	476
<b>CHAPTER 7</b>	<b>Applications of Regression II</b>	<b>501</b>
7.1	Overview	501
7.2	Subset Analysis and Variable Selection	501
7.3	All-Subsets Regression	504
7.4	Alternative Methods for Subset Selection	520
7.5	Growth Curves	551
7.6	Exercises	567
<b>CHAPTER 8</b>	<b>Alternate Assumptions for Regression</b>	<b>571</b>
8.1	Overview	571
8.2	Straight Line Regression with Unequal Subpopulation Standard Deviations	571
8.3	Straight Line Regression—Theil's Method	584
8.4	Exercises	592

<b>CHAPTER 9</b>	<b>Nonlinear Regression</b>	<b>599</b>
9.1	Overview	599
9.2	Some Commonly Used Families of Nonlinear Regression Functions	599
9.3	Statistical Assumptions and Inferences for Nonlinear Regression	605
9.4	Linearizable Models	615
9.5	Exercises	622
<b>Appendix A: Answers to Selected Problems and Exercises</b>		<b>627</b>
<b>Appendix B: Bibliography</b>		<b>645</b>
<b>Appendix D: Data Sets</b>		<b>647</b>
	Table D-1: Car Data	649
	Table D-2: Car2 Data	657
	Table D-3: Grades Data	659
	Table D-4: Plastic Data	669
<b>Appendix T: Tables</b>		<b>679</b>
	Table T-1: Percentiles of a Standard Gaussian Population	681
	Table T-2: Percentiles of a Student's $t$ Population	682
	Table T-3: Percentiles of a Chi-Square Population	683
	Table T-4: Student's $t$ for $m$ Simultaneous Confidence Intervals for $m = 2, 3, 4, 5, 6$	684
	Table T-5: Percentiles of Snedecor's $F$ Population	689
	Table T-6: Table for Obtaining Confidence Bounds for $a_0\beta_0 + a_1\beta_1$ Using Theil's Method	692
	Table T-7: Charts for Confidence Bounds for the Simple Correlation Coefficient	693
	Table T-8: Selected Percentiles of the Noncentral $t$	695
<b>Index</b>		<b>697</b>