ESSENTIALS OF STATISTICS FOR BUSINESS AND ECONOMICS 6e

David R. Anderson

University of Cincinnati

Dennis J. Sweeney University of Cincinnati

Thomas A. Williams Rochester Institute of Technology



Australia · Brazil · Canada · Mexico · Singapore · Spain · United Kingdom · United States

Copyright 2010 Cengage Learning. All Rights Reserved. May not be copied, scanned, or duplicated, in whole or in part. Due to electronic rights, some third party content may be suppressed from the eBook and/or eChapter(s). Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

Preface xxi	
About the Authority	ors xxix
Chapter 1	Data and Statistics 1
Chapter 2	Descriptive Statistics: Tabular and Graphical Presentations 31
Chapter 3	Descriptive Statistics: Numerical Measures 86
Chapter 4	Introduction to Probability 148
Chapter 5	Discrete Probability Distributions 193
Chapter 6	Continuous Probability Distributions 232
Chapter 7	Sampling and Sampling Distributions 265
Chapter 8	Interval Estimation 304
Chapter 9	Hypothesis Tests 344
Chapter 10	Comparisons Involving Means, Experimental Design, and Analysis of Variance 392
Chapter 11	Comparisons Involving Proportions and a Test of Independence 448
Chapter 12	Simple Linear Regression 483
Chapter 13	Multiple Regression 552
Appendix A	References and Bibliography 602
Appendix B	Tables 604
Appendix C	Summation Notation 631
Appendix D	Self-Test Solutions and Answers to Even-Numbered Exercises 633
Appendix E	Using Excel Functions 665
Appendix F	Computing <i>p</i> -Values Using Minitab and Excel 670
Index 674	

Preface xxi About the Authors xxix

Chapter 1 Data and Statistics 1

Statistics in Practice: Businessweek 2

- 1.1 Applications in Business and Economics 3
 - Accounting 3 Finance 4 Marketing 4 Production 4 Economics 4

1.2 Data 5

Elements, Variables, and Observations 5 Scales of Measurement 6 Categorical and Quantitative Data 7 Cross-Sectional and Time Series Data 7

1.3 Data Sources 10

Existing Sources 10 Statistical Studies 11 Data Acquisition Errors 13

- 1.4 Descriptive Statistics 13
- 1.5 Statistical Inference 15
- 1.6 Computers and Statistical Analysis 17
- 1.7 Data Mining 17
- **1.8** Ethical Guidelines for Statistical Practice 18

Summary 20

Glossary 20

Supplementary Exercises 21

Appendix An Introduction to StatTools 28

Chapter 2 Descriptive Statistics: Tabular and Graphical Presentations 31

Statistics in Practice: Colgate-Palmolive Company 32

2.1 Summarizing Categorical Data 33
 Frequency Distribution 33
 Relative Frequency and Percent Frequency Distributions 34
 Bar Charts and Pie Charts 34

2.2 Summarizing Quantitative Data 39

Frequency Distribution 39 Relative Frequency and Percent Frequency Distributions 41 Dot Plot 41 Histogram 42 Cumulative Distributions 44 Ogive 44

- 2.3 Exploratory Data Analysis: The Stem-and-Leaf Display 49
- 2.4 Crosstabulations and Scatter Diagrams 54

Crosstabulation 54 Simpson's Paradox 57 Scatter Diagram and Trendline 58

Summary 64

Glossary 65

Key Formulas 66

Supplementary Exercises 66

Case Problem 1: Pelican Stores 72

Case Problem 2: Motion Picture Industry 73

Appendix 2.1 Tabular and Graphical Presentations Using Minitab 74

Appendix 2.2 Tabular and Graphical Presentations Using Excel 76

Appendix 2.3 Tabular and Graphical Presentations Using StatTools 85

Chapter 3 Descriptive Statistics: Numerical Measures 86

Statistics in Practice: Small Fry Design 87

3.1 Measures of Location 88

Mean 88 Median 89 Mode 90 Percentiles 91 Quartiles 92

3.2 Measures of Variability 96

Range 97 Interquartile Range 97 Variance 98 Standard Deviation 100 Coefficient of Variation 100

3.3 Measures of Distribution Shape, Relative Location, and Detection of Outliers 103

Distribution Shape 103 z-Scores 104 Chebyshev's Theorem 105 Empirical Rule 106 Detection of Outliers 107

3.4 Exploratory Data Analysis 110 Five-Number Summary 110 Box Plot 111

3.5 Measures of Association Between Two Variables 116

Covariance 116 Interpretation of the Covariance 118 Correlation Coefficient 120 Interpretation of the Correlation Coefficient 121

3.6 The Weighted Mean and Working with Grouped Data 125 Weighted Mean 125

Grouped Data 126

Summary 131

Glossary 131

Key Formulas 133

Supplementary Exercises 134

Case Problem 1: Pelican Stores 138

Case Problem 2: Motion Picture Industry 140

Case Problem 3: Heavenly Chocolates Website Transactions 140

Appendix 3.1 Descriptive Statistics Using Minitab 141

Appendix 3.2 Descriptive Statistics Using Excel 143

Appendix 3.3 Descriptive Statistics Using StatTools 146

Chapter 4 Introduction to Probability 148

Statistics in Practice: Oceanwide Seafood 149

- **4.1 Experiments, Counting Rules, and Assigning Probabilities 150** Counting Rules, Combinations, and Permutations 151 Assigning Probabilities 155 Probabilities for the KP&L Project 157
- 4.2 Events and Their Probabilities 160

4.3 Some Basic Relationships of Probability 164 Complement of an Event 164 Addition Law 165 **Conditional Probability 171** 4.4 Independent Events 174 Multiplication Law 174 4.5 **Bayes' Theorem 178** Tabular Approach 182 Summary 184 **Glossary 184 Kev Formulas** 185 **Supplementary Exercises** 186 **Case Problem: Hamilton County Judges 190**

Chapter 5 Discrete Probability Distributions 193

Statistics in Practice: Citibank 194

- 5.1 Random Variables 194 Discrete Random Variables 195 Continuous Random Variables 196
- 5.2 Discrete Probability Distributions 197
- 5.3 Expected Value and Variance 202 Expected Value 202 Variance 203
- 5.4 Binomial Probability Distribution 207

A Binomial Experiment 208 Martin Clothing Store Problem 209 Using Tables of Binomial Probabilities 213 Expected Value and Variance for the Binomial Distribution 214

5.5 Poisson Probability Distribution 218
 An Example Involving Time Intervals 218
 An Example Involving Length or Distance Intervals 220

5.6 Hypergeometric Probability Distribution 221

Summary 225

Glossary 226

Key Formulas 226

Supplementary Exercises 227

Appendix 5.1 Discrete Probability Distributions Using Minitab 230 Appendix 5.2 Discrete Probability Distributions Using Excel 230

Chapter 6 Continuous Probability Distributions 232

Statistics in Practice: Procter & Gamble 233

6.1 Uniform Probability Distribution 234

Area as a Measure of Probability 235

- **6.2 Normal Probability Distribution 238** Normal Curve 238 Standard Normal Probability Distribution 240 Computing Probabilities for Any Normal Probability Distribution 245 Grear Tire Company Problem 246
- 6.3 Normal Approximation of Binomial Probabilities 250

6.4 Exponential Probability Distribution 254

Computing Probabilities for the Exponential Distribution 254 Relationship Between the Poisson and Exponential Distributions 255

Summary 257

Glossary 258

Key Formulas 258

Supplementary Exercises 259

Case Problem: Specialty Toys 262

Appendix 6.1 Continuous Probability Distributions Using Minitab 263Appendix 6.2 Continuous Probability Distributions Using Excel 263

Chapter 7 Sampling and Sampling Distributions 265

Statistics in Practice: Meadwestvaco Corporation 266

- 7.1 The Electronics Associates Sampling Problem 267
- **7.2 Selecting a Sample 268** Sampling from a Finite Population 268 Sampling from an Infinite Population 270
- **7.3 Point Estimation 273** Practical Advice 275
- 7.4 Introduction to Sampling Distributions 276
- 7.5 Sampling Distribution of \bar{x} 278
 - Expected Value of \overline{x} 279 Standard Deviation of \overline{x} 280 Form of the Sampling Distribution of \overline{x} 281 Sampling Distribution of \overline{x} for the EAI Problem 283 Practical Value of the Sampling Distribution of \overline{x} 283 Relationship Between the Sample Size and the Sampling Distribution of \overline{x} 285

7.6

	Other Bamping Methods 275
	Stratified Random Sampling 295
	Cluster Sampling 295
	Systematic Sampling 296
	Convenience Sampling 296
	Judgment Sampling 297
Sun	imary 297
Glo	ssary 298
Key	Formulas 299
Sup	plementary Exercises 299
Ann	endix 7.1 Random Sampling Using Minitab 301
TTAPP	
	endix 7.2 Random Sampling Using Excel 302
App App	endix 7.2 Random Sampling Using Excel 302 endix 7.3 Random Sampling Using StatTools 302
App App	endix 7.2 Random Sampling Using Excel 302 endix 7.3 Random Sampling Using StatTools 302
App App App Ch	apter 8 Interval Estimation 304
App App App Ch Stat	endix 7.2 Random Sampling Using Excel 302 endix 7.3 Random Sampling Using StatTools 302 apter 8 Interval Estimation 304 istics in Practice: Food Lion 305
App App App Ch Stat 8.1	apter 8Interval Estimation304istics in Practice: Food Lion305Population Mean: σ Known306
App App Ch Stat 8.1	 apter 8 Interval Estimation 304 istics in Practice: Food Lion 305 Population Mean: σ Known 306 Margin of Error and the Interval Estimate 306
App App Ch Stat 8.1	 apter 8 Interval Estimation 304 istics in Practice: Food Lion 305 Population Mean: σ Known 306 Margin of Error and the Interval Estimate 306 Practical Advice 310

Sampling Distribution of \overline{p} 289 Expected Value of \overline{p} 289 Standard Deviation of \overline{p} 290

Form of the Sampling Distribution of \overline{p} 291

Practical Value of the Sampling Distribution of \overline{p} 291

Margin of Error and the Interval Estimate 313 Practical Advice 316 Using a Small Sample 316 Summary of Interval Estimation Procedures 318

8.3 Determining the Sample Size 321

8.4 Population Proportion 324 Determining the Sample Size 326

Summary 329

Glossary 330

Key Formulas 331

Supplementary Exercises 331

Case Problem 1: Young Professional Magazine 334 Case Problem 2: Gulf Real Estate Properties 335 Case Problem 3: Metropolitan Research, Inc. 337 Appendix 8.1 Interval Estimation Using Minitab 338 Appendix 8.2 Interval Estimation Using Excel 339 Appendix 8.3 Interval Estimation Using StatTools 341

Chapter 9 Hypothesis Tests 344

Statistics in Practice: John Morrell & Company 345

9.1 Developing Null and Alternative Hypotheses 346 The Alternative Hypothesis as a Research Hypothesis 346 The Null Hypothesis as an Assumption to Be Challenged 347 Summary of Forms for Null and Alternative Hypotheses 348

9.2 Type I and Type II Errors 349

9.3 Population Mean: σ Known 352

One-Tailed Test 352 Two-Tailed Test 358 Summary and Practical Advice 361 Relationship Between Interval Estimation and Hypothesis Testing 362

9.4 Population Mean: *σ* Unknown 367 One-Tailed Test 367 Two-Tailed Test 368

Summary and Practical Advice 370

9.5 Population Proportion 373

Summary 375

Summary 378

Glossary 378

Key Formulas 379

Supplementary Exercises 379

Case Problem 1: Quality Associates, Inc. 382

Case Problem 2: Ethical Behavior of Business Students at Bayview University 383

Appendix 9.1 Hypothesis Testing Using Minitab 385

Appendix 9.2 Hypothesis Testing Using Excel 386

Appendix 9.3 Hypothesis Testing Using StatTools 391

Chapter 10 Comparisons Involving Means, Experimental Design, and Analysis of Variance 392

Statistics in Practice: U.S. Food and Drug Administration 393

10.1 Inferences About the Difference Between Two Population Means: σ_1 and σ_2 Known 394 Interval Estimation of $\mu_1 - \mu_2$ 394 Hypothesis Tests About $\mu_1 - \mu_2$ 397

Practical Advice 398

- 10.2 Inferences About the Difference Between Two Population Means: σ_1 and σ_2 Unknown 401 Interval Estimation of $\mu_1 - \mu_2$ 401 Hypothesis Tests About $\mu_1 - \mu_2$ 403 Practical Advice 405
- 10.3 Inferences About the Difference Between Two Population Means: Matched Samples 409

10.4 An Introduction to Experimental Design and Analysis of Variance 414

Data Collection 416 Assumptions for Analysis of Variance 417 Analysis of Variance: A Conceptual Overview 417

10.5 Analysis of Variance and the Completely Randomized Design 420

Between-Treatments Estimate of Population Variance 421 Within-Treatments Estimate of Population Variance 422 Comparing the Variance Estimates: The *F* Test 423 ANOVA Table 424 Computer Results for Analysis of Variance 425 Testing for the Equality of *k* Population Means: An Observational Study 427

Summary 431

Glossary 431

Key Formulas 431

Supplementary Exercises 433

Case Problem 1: Par, Inc. 438

Case Problem 2: Wentworth Medical Center 438

Case Problem 3 Compensation for Sales Professionals 439

Appendix 10.1 Inferences About Two Populations Using Minitab 440

Appendix 10.2 Analysis of Variance Using Minitab 442

Appendix 10.3 Inferences About Two Populations Using Excel 442

Appendix 10.4 Analysis of Variance Using Excel 443

Appendix 10.5 Inferences About Two Populations Using StatTools 444

Appendix 10.6 Analysis of Variance Using StatTools 446

Chapter 11 Comparisons Involving Proportions and a Test of Independence 448

Statistics in Practice: United Way 449

- 11.1 Inferences About the Difference Between Two Population Proportions 450 Interval Estimation of $p_1 - p_2$ 450 Hypothesis Tests About $p_1 - p_2$ 452
- 11.2 Hypothesis Test for Proportions of a Multinomial Population 456
- 11.3 Test of Independence 463

Summary 471

Glossary 471

Key Formulas 471

Supplementary Exercises 472

Case Problem: A Bipartisan Agenda for Change 477

Appendix 11.1 Inferences About Two Population Proportions Using Minitab 477

Appendix 11.2 Tests of Goodness of Fit and Independence Using Minitab 478

Appendix 11.3 Tests of Goodness of Fit and Independence Using Excel 479

Appendix 11.4 Inferences About Two Population Proportions Using StatTools 480

Appendix 11.5 Test of Independence Using StatTools 482

Chapter 12 Simple Linear Regression 483

Statistics in Practice: Alliance Data Systems 484

- **12.1 Simple Linear Regression Model 485** Regression Model and Regression Equation 485 Estimated Regression Equation 486
- 12.2 Least Squares Method 488
- **12.3 Coefficient of Determination 499** Correlation Coefficient 502
- 12.4 Model Assumptions 506
- 12.5 Testing for Significance 508 Estimate of σ^2 508 *t* Test 509 Confidence Interval for β_1 510 *F* Test 511 Some Cautions About the Interpretation of Significance Tests 513

Prediction 517

12.6

Point Estimation 517 Interval Estimation 517 Confidence Interval for the Mean Value of y 518 Prediction Interval for an Individual Value of v 519 12.7 **Computer Solution 523** 12.8 Residual Analysis: Validating Model Assumptions 527 Residual Plot Against x = 529Residual Plot Against \hat{v} 531 Summary 533 **Glossary 534 Key Formulas 535** Supplementary Exercises 536 Case Problem 1: Measuring Stock Market Risk 543 Case Problem 2: U.S. Department of Transportation 544 Case Problem 3: Alumni Giving 545 **Case Problem 4: PGA Tour Statistics 545** Appendix 12.1 Regression Analysis Using Minitab 547 Appendix 12.2 Regression Analysis Using Excel 548 Appendix 12.3 Regression Analysis Using StatTools 550

Using the Estimated Regression Equation for Estimation and

Chapter 13 Multiple Regression 552

Statistics in Practice: International Paper 553

- 13.1 Multiple Regression Model 554 Regression Model and Regression Equation 554 Estimated Multiple Regression Equation 554
- 13.2 Least Squares Method 555 An Example: Butler Trucking Company 556 Note on Interpretation of Coefficients 558
- 13.3 Multiple Coefficient of Determination 564
- 13.4 Model Assumptions 567
- 13.5 Testing for Significance 568 F Test 569 t Test 571 Multicollinearity 572
- 13.6 Using the Estimated Regression Equation for Estimation and Prediction 576
- 13.7 Categorical Independent Variables 578 An Example: Johnson Filtration, Inc. 578

Key Formulas 587 Supplementary Exercises 588 Case Problem 1: Consumer Research, Inc. 594 Case Problem 2: Alumni Giving 595 Case Problem 3: PGA Tour Statistics 597 Case Problem 4: Predicting Winning Percentage for the NFL 598 Appendix 13.1 Multiple Regression Using Minitab 599 Appendix 13.2 Multiple Regression Using Excel 599 Appendix 13.3 Multiple Regression Using StatTools 600

Appendix A References and Bibliography 602

Appendix BTables 604Appendix CSummation Notation 631Appendix DSelf-Test Solutions and Answers to Even-Numbered
Exercises 633Appendix EUsing Excel Functions 665Appendix FComputing p-Values Using Minitab and Excel 670
Index 674