

CONTENTS

Preface	xi
1 Introduction	1
1.1 Book Overview	3
1.2 Chapter Summaries	4
1.3 How to Use This Book	5
1.4 Why Learn to Analyze Data?	6
1.4.1 Learning to Code	6
1.5 Getting Ready	7
1.6 Introduction to R	8
1.6.1 Doing Calculations in R	9
1.6.2 Creating Objects in R	10
1.6.3 Using Functions in R	12
1.7 Loading and Making Sense of Data	14
1.7.1 Setting the Working Directory	15
1.7.2 Loading the Dataset	15
1.7.3 Understanding the Data	16
1.7.4 Identifying the Types of Variables Included	19
1.7.5 Identifying the Number of Observations . .	20
1.8 Computing and Interpreting Means	21
1.8.1 Accessing Variables inside Dataframes . . .	21
1.8.2 Means	22
1.9 Summary	24
1.10 Cheatsheets	25
1.10.1 Concepts and Notation	25
1.10.2 R Symbols and Operators	26
1.10.3 R Functions	26
2 Estimating Causal Effects with Randomized Experiments	27
2.1 Project STAR	27
2.2 Treatment and Outcome Variables	28
2.2.1 Treatment Variables	29
2.2.2 Outcome Variables	29
2.3 Individual Causal Effects	29
2.4 Average Causal Effects	33
2.4.1 Randomized Experiments and the Difference-in-Means Estimator	35
2.5 Do Small Classes Improve Student Performance? .	39

2.5.1	Relational Operators in R	39
2.5.2	Creating New Variables	40
2.5.3	Subsetting Variables	42
2.6	Summary	46
2.7	Cheatsheets	47
2.7.1	Concepts and Notation	47
2.7.2	R Symbols and Operators	50
2.7.3	R Functions	50
3	Inferring Population Characteristics via Survey Research	51
3.1	The EU Referendum in the UK	51
3.2	Survey Research	52
3.2.1	Random Sampling	53
3.2.2	Potential Challenges	54
3.3	Measuring Support for Brexit	55
3.3.1	Predicting the Referendum Outcome	56
3.3.2	Frequency Tables	57
3.3.3	Tables of Proportions	57
3.4	Who Supported Brexit?	58
3.4.1	Handling Missing Data	59
3.4.2	Two-Way Frequency Tables	62
3.4.3	Two-Way Tables of Proportions	64
3.4.4	Histograms	66
3.4.5	Density Histograms	68
3.4.6	Descriptive Statistics	71
3.5	Relationship between Education and the Leave Vote in the Entire UK	76
3.5.1	Scatter Plots	78
3.5.2	Correlation	82
3.6	Summary	88
3.7	Cheatsheets	90
3.7.1	Concepts and Notation	90
3.7.2	R Symbols and Operators	96
3.7.3	R Functions	96
4	Predicting Outcomes Using Linear Regression	98
4.1	GDP and Night-Time Light Emissions	98
4.2	Predictors, Observed vs. Predicted Outcomes, and Prediction Errors	99
4.3	Summarizing the Relationship between Two Variables with a Line	100
4.3.1	The Linear Regression Model	101
4.3.2	The Intercept Coefficient	103
4.3.3	The Slope Coefficient	104
4.3.4	The Least Squares Method	106
4.4	Predicting GDP Using Prior GDP	107
4.4.1	Relationship between GDP and Prior GDP	109
4.4.2	With Natural Logarithm Transformations	113
4.5	Predicting GDP Growth Using Night-Time Light Emissions	116

4.6	Measuring How Well the Model Fits the Data with the Coefficient of Determination, R^2	120
4.6.1	How Well Do the Three Predictive Models in This Chapter Fit the Data?	122
4.7	Summary	123
4.8	Appendix: Interpretation of the Slope in the Log-Log Linear Model	124
4.9	Cheatsheets	126
4.9.1	Concepts and Notation	126
4.9.2	R Functions	128
5	Estimating Causal Effects with Observational Data	129
5.1	Russian State-Controlled TV Coverage of 2014 Ukrainian Affairs	129
5.2	Challenges of Estimating Causal Effects with Observational Data	130
5.2.1	Confounding Variables	130
5.2.2	Why Are Confounders a Problem?	131
5.2.3	Confounders in Randomized Experiments	133
5.3	The Effect of Russian TV on Ukrainians' Voting Behavior	135
5.3.1	Using the Simple Linear Model to Compute the Difference-in-Means Estimator	136
5.3.2	Controlling for Confounders Using a Multiple Linear Regression Model	142
5.4	The Effect of Russian TV on Ukrainian Electoral Outcomes	147
5.4.1	Using the Simple Linear Model to Compute the Difference-in-Means Estimator	149
5.4.2	Controlling for Confounders Using a Multiple Linear Regression Model	151
5.5	Internal and External Validity	153
5.5.1	Randomized Experiments vs. Observational Studies	153
5.5.2	The Role of Randomization	154
5.5.3	How Good Are the Two Causal Analyses in This Chapter?	155
5.5.4	How Good Was the Causal Analysis in Chapter 2?	156
5.5.5	The Coefficient of Determination, R^2	157
5.6	Summary	157
5.7	Cheatsheets	159
5.7.1	Concepts and Notation	159
5.7.2	R Functions	161
6	Probability	162
6.1	What Is Probability?	162
6.2	Axioms of Probability	163
6.3	Events, Random Variables, and Probability Distributions	165

6.4	Probability Distributions	166
6.4.1	The Bernoulli Distribution	166
6.4.2	The Normal Distribution	169
6.4.3	The Standard Normal Distribution	173
6.4.4	Recap	179
6.5	Population Parameters vs. Sample Statistics	179
6.5.1	The Law of Large Numbers	180
6.5.2	The Central Limit Theorem	183
6.5.3	Sampling Distribution of the Sample Mean	188
6.6	Summary	189
6.7	Appendix: For Loops	190
6.8	Cheatsheets	192
6.8.1	Concepts and Notation	192
6.8.2	R Symbols and Operators	194
6.8.3	R Functions	195
7	Quantifying Uncertainty	196
7.1	Estimators and Their Sampling Distributions	196
7.2	Confidence Intervals	202
7.2.1	For the Sample Mean	203
7.2.2	For the Difference-in-Means Estimator	206
7.2.3	For Predicted Outcomes	209
7.3	Hypothesis Testing	211
7.3.1	With the Difference-in-Means Estimator	218
7.3.2	With Estimated Regression Coefficients	220
7.4	Statistical vs. Scientific Significance	224
7.5	Summary	225
7.6	Cheatsheets	226
7.6.1	Concepts and Notation	226
7.6.2	R Symbols and Operators	229
7.6.3	R Functions	229
	Index of Concepts	231
	Index of Mathematical Notation	235
	Index of R and RStudio	237