Contents

	List of figures List of tables List of panels Profess	<i>page</i> xiii xvii xix	
Part I	Preface	xxi	
Farti	Elementary statistical analysis		
Chapter 1	Introduction	3	
1.1	Aims of the book	3	
1.2	The four case studies and the data sets	6	
1.3	Types of measurement	7	
	1.3.1 Cases, variables, and values	8	
	1.3.2 Cross-section and time-series variables	8	
	1.3.3 Levels of measurement	9	
	1.3.4 Populations and samples	10	
	1.3.5 Dummy variables	11	
1.4	Simple notation	12	
1.5	The equation of a straight line 13		
1.6	Powers and logarithms		
	1.6.1 Powers	14	
	1.6.2 Logarithms	16	
	1.6.3 Logs as proportions and ratios	17	
1.7	Index numbers	19	
1.8	Trends and fluctuations	21	
	1.8.1 Measuring the trend by a moving average	22	
	1.8.2 Measuring the fluctuations by the ratio to the trend	25	
Chapter 2	Descriptive statistics	33	
2.1	Presentation of numerical data	33	
	2.1.1 Frequency distributions	33	



	2.1.2	Bar charts and histograms	36
	2.1.3	Frequency curves	40
2.2	Measures	s of central tendency	42
	2.2.1	The mean, the median, and the mode	43
	2.2.2	Weighted averages and standardized rates	44
	2.2.3	Percentiles, deciles, and quartiles	46
2.3	Measures	s of dispersion	47
	2.3.1	The range and the quartile deviation	47
	2.3.2	The mean deviation, the variance, and the standard deviation	47
	2.3.3	The coefficient of variation	50
2.4	Measures	s of central tendency and dispersion with grouped data	51
	2.4.1	The median and mean with grouped data	51
	2.4.2	The variance and standard deviation with grouped data	52
2.5	The shap	e of the distribution	53
	2.5.1	Symmetrical and skewed distributions	53
	2.5.2	Measures of skewness	55
2.6		nal distribution	56
	2.6.1	Properties of the normal distribution	56
	2.6.2	The standard normal distribution	61
2.7	Exercises	s for chapter 2	66
Chapter 3	Correlat	tion	71
Chapter 3 3.1		tion cept of correlation	71
-	The cond		71 72
-	The cond	cept of correlation	71 72 72
-	The cond 3.1.1	cept of correlation Correlation is not causation Scatter diagrams and correlation	71 72 72 74
-	The cond 3.1.1 3.1.2 3.1.3	cept of correlation Correlation is not causation Scatter diagrams and correlation	71 72 72 74 76
3.1	The cond 3.1.1 3.1.2 3.1.3	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient	71 72 72 74 76 76
3.1	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient	71 72 72 74 76 76 77
3.1	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r	71 72 72 74 76 76 77 82
3.1	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients	71 72 72 74 76 76 76 77 82 83
3.1 3.2 3.3	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient	71 72 72 74 76 76 76 77 82 83 83
3.1	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients	71 72 72 74 76 76 76 77 82 83
3.1 3.2 3.3	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient	71 72 72 74 76 76 76 77 82 83 83
3.1 3.2 3.3 3.4	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise Simple I	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient s for chapter 3	71 72 74 76 76 76 77 82 83 86 90
3.1 3.2 3.3 3.4 Chapter 4	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise Simple I	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient s for chapter 3	71 72 72 74 76 76 76 76 76 77 82 83 86 90 93
3.1 3.2 3.3 3.4 Chapter 4	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise Simple I The con	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient s for chapter 3 linear regression cept of regression	71 72 72 74 76 76 76 76 77 82 83 86 90 93 93
3.1 3.2 3.3 3.4 Chapter 4	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise Simple I The con 4.1.1 4.1.2	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient s for chapter 3 linear regression cept of regression Explanatory and dependent variables	71 72 72 74 76 76 76 76 77 82 83 86 90 93 93 93 93
3.1 3.2 3.3 3.4 Chapter 4 4.1	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise Simple I The con 4.1.1 4.1.2	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient s for chapter 3 linear regression cept of regression Explanatory and dependent variables The questions addressed by regression he regression line	71 72 72 74 76 76 76 76 76 77 82 83 86 90 93 93 93 93 94
3.1 3.2 3.3 3.4 Chapter 4 4.1	The cond 3.1.1 3.1.2 3.1.3 The corr 3.2.1 3.2.2 3.2.3 3.2.4 Spearma Exercise Simple I The con 4.1.1 4.1.2 Fitting t	cept of correlation Correlation is not causation Scatter diagrams and correlation Outliers relation coefficient Measuring the strength of the association Derivation of the correlation coefficient, r Interpreting a correlation coefficient An illustration of the use of correlation coefficients an's rank correlation coefficient s for chapter 3 linear regression cept of regression Explanatory and dependent variables The questions addressed by regression he regression line	71 72 72 74 76 76 76 76 77 82 83 86 90 93 93 93 93 93 94 95



CONTENTS

	4.2.4	The regression of Y on X versus the regression of X on Y	99
	4.2.5	Fitting a linear trend to a time series	100
4.3	Measuri	ng the goodness of fit	102
	4.3.1	Explained variations and unexplained variations (residuals)	102
	4.3.2	The coefficient of determination, r ²	105
	4.3.3	Some intuitive implications	106
4.4	Introducing the Ballantine		110
4.5	Exercises for chapter 4		112

Part II Samples and inductive statistics

Chapter 5	Standar	d errors and confidence intervals	117
5.1	Introduc	ction	117
5.2	Samplin	g distributions	120
	5.2.1	Sampling distributions and point estimates of the population	
		mean	120
5.3	Four fun	damental statistical propositions	122
	5.3.1	The Central Limit Theorem	122
5.4	Theoreti	cal probability distributions	125
	5.4.1	Empirical and theoretical frequency distributions	125
	5.4.2	The Z- and t-distributions	131
5.5	Confider	nce intervals for a sample mean	136
	5.5.1	Interval estimates and margins of error	137
	5.5.2	Confidence interval for an estimate of a population mean	137
5.6	Confide	nce intervals for other sample statistics	140
	5.6.1	Sample proportions	141
	5.6.2	Correlation coefficients	141
	5.6.3	Regression coefficients	143
5.7	Exercises	s for chapter 5	145
Chapter 6	Hypothe	esis testing	149
6.1	Testing h	ypotheses	149
	6.1.1	A simple illustration	150
	6.1.2	The five stages of hypothesis testing	151
6.2	The null	hypothesis	151
	6.2.1	Other assumptions of the model	152
6.3	How cor	fident do we want to be about the results?	153
	6.3.1	Two types of error and the null hypothesis	153
	6.3.2	Significance levels and the critical region	155
	6.3.3	One- and two-tailed tests	158
	6.3.4	Statistical versus historical significance	160

vii

	6.3.5	Conventional significance levels and prob-values	160
	6.3.6	The critical region and the four cases of theft	162
6.4	Test stati	stics and their sampling distributions	163
	6.4.1	The basic ideas	163
	6.4.2	Z- and t-tests	164
6.5	Makinga	a decision	167
6.6	Interpret	ting the results	170
6.7	Three illu	ustrations of the use of t-tests	170
	6.7.1	A t-test for a difference of means	170
	6.7.2	A <i>t</i> -test for a correlation coefficient when the null hypothesis is	
		zero correlation	173
	6.7.3	A <i>t</i> -test for a regression coefficient	175
6.8	Exercises	s for chapter 6	181
Chapter 7	Non-par	rametric tests	185
7.1	Introduc		185
7.2	Non-par	ametric tests for two independent samples	187
	-	The Wald–Wolfowitz runs test	188
	7.2.2	The Mann–Whitney U-test	193
	7.2.3	The Kolmogorov–Smirnov test	198
	7.2.4	Criteria for choosing between alternative tests	201
7.3	The χ^2 -to	est	202
	7.3.1	Contingency tables or cross-tabulations	203
	7.3.2	The χ^2 -test for a relationship between two variables	204
7.4	The one-	sample runs test of randomness	210
7.5	One-sam	pple non-parametric tests of goodness of fit	216
	7.5.1	The one-sample χ^2 -test	216
	7.5.2	The one-sample Kolmogorov–Smirnov test	216
7.6	Non-par	ametric measures of strength of association	218
	7.6.1	Four measures of association: ϕ , Cramer's V, the contingency	010
		coefficient C, and Goodman and Kruskal's tau	218
7.7	Exercises	s for chapter 7	224
Part III	Multip	e linear regression	
Chapter 8	Multiple	erelationships	231
8.1	-	usion of additional explanatory variables	231
8.2		regression	232
	8.2.1	e e e e e e e e e e e e e e e e e e e	232
	8.2.2	1	234
	8.2.3	6	
		variable	235



CONTENTS

	8.2.4	Understanding the impact of additional explanatory	
		variables	238
	8.2.5	The Ballantine for multiple regression	240
	8.2.6	The least squares criterion in multiple regression	242
	8.2.7	Standardized beta coefficients	243
	8.2.8	The adjusted coefficient of multiple determination, \overline{R}^2	245
	8.2.9	Interpreting the intercept term	246
8.3	Partial ar	nd multiple correlation	248
	8.3.1	The interpretation and order of partial correlation	
		coefficients	248
	8.3.2	Removing the influence of the control variable	252
	8.3.3	1	253
	8.3.4	The coefficient of multiple correlation, R	254
8.4	Exercises	s for chapter 8	255
Chapter 9	The class	sical linear regression model	258
9.1	Historica	al research and models of relationships between variables	258
	9.1.1	Quantitative methods and historical judgement	260
9.2	Deviation	ns of the dependent variable from the estimated regression	
	line		261
	9.2.1	Errors of measurement and specification	261
	9.2,2	Stochastic (random) factors and the error term, e	262
	9.2.3	Sampling and the regression line	263
		Assumptions about the error term	264
9.3	A signific	cance test for the regression as a whole	268
	9.3.1	The F-test and the F-distribution	269
	9.3.2	F-tests of the statistical significance of the regression as a	
		whole	269
		The relationship of F and R ²	271
9.4	The stand	dard error of the estimate, SEE	272
	9.4.1	Confidence interval for a prediction of the mean value of a	
		dependent variable	273
	9.4.2	Confidence interval for a prediction of a specific value of	
		a dependent variable	276
9.5	Exercises	for chapter 9	277
Chapter 10	•	variables and lagged values	280
10.1	Dummy	variables	280
	10.1.1	Dummy variables with two or more categories	280
	10.1.2	Dummy variables as a change in the intercept	283
	10.1.3	Additional dummy variables	285

ix



	10.1.4	Interaction between two dummy variables	286
	10.1.5	Interaction between dummy and numerical variables	287
10.2	Lagged va	riables	289
	10.2.1	Lagged dependent variables	291
	10.2.2	Distributed lag models	292
10.3	Exercises	for chapter 10	295
Chapter 11	Violating	the assumptions of the classical linear regression model	300
11.1	The assur	nptions of the classical linear regression model	300
	11.1.1	The model is correctly specified	301
	11.1.2	The error term is appropriately specified	301
	11.1.3	The variables are correctly measured and appropriately	
		specified	301
11.2	Problems	of model specification	302
	11.2.1	Non-linear models	302
	11.2.2	Omitted and redundant variables	303
	11.2.3	Unstable parameter values	305
11.3	Problems	s of error specification	308
	11.3.1	Non-zero errors	308
	11.3.2	Heteroscedasticity	309
	11.3.3	Autocorrelation	311
	11.3.4	Outliers	316
11.4	Problems	s of variable specification	319
	11.4.1	Errors in variables	319
	11.4.2	Multicollinearity	321
	11.4.3	Simultaneity	324
11.5	Exercises	for chapter 11	326
Part IV	Furthe	r topics in regression analysis	
Chapter 12	Non-line	ear models and functional forms	333
12.1	Different	t forms of non-linear relationships	334
12.2	Estimatio	on of non-linear regression models	341
	12.2.1	Two groups of non-linear models	342
	12.2.2	Estimating the double logarithmic and semi-logarithmic	245
10.2	T	models	345
12.3		tation of non-linear relationships	347
	12.3.1	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	247
	10.0.0	models	347
	12.3.2		349
	12.3.3	Long-run multipliers	351

CONTENT	s
---------	---

12.4	Eistin mar		251
12.4	-	trend to a time series	351
	12.4.1	Fitting a log-linear trend	351
10.5		Fitting non-linear trends	352
12.5		g a relationship	359
		Choice of functional form	360
		Some general principles	362
	12.5.3	Implementing the principles: some examples from economic	
		history	363
	12.5.4	Implementing the principles: some examples from demographic,	
		social, and political history	367
12.6	-	ecification	372
12.7	Exercises	for chapter 12	380
Chamber 12	T		204
Chapter 13	-	bbit, and tobit models	384
13.1		lependent variables	385
	13.1.1	Three cases of limited dependent variables	385
	13.1.2	Why linear models are not appropriate for limited dependent	207
12.2	P	variables	387
13.2		g the logit model: coefficients, absolute effects, and	200
	elasticitie		390
	13.2.1	The logit regression model	390
	13.2.2	Interpreting logit coefficients	391
	13.2.3	Absolute changes: marginal effects and impact	
		effects	399
		Calculating the marginal and impact effects	402
	13.2.5	Proportionate effects: logit elasticities	406
	13.2.6	Non-linearity and the measurement of change	412
7	13.2.7		413
13.3		g the logit model: an illustration	415
	13.3.1	An illustration of the logit model	415
	13.3.2	Estimating the logit model using grouped data	418
13.4		g the probit model	419
	13.4.1	The probit model	419
		Interpreting the results from a probit model	420
13.5		ponse models	422
13.6		dependent variables	423
	13.6.1	A censored continuous dependent variable	423
	13.6.2	The tobit model	424
	13.6.3	Two-part censored models	427
13.7	Exercises	for chapter 13	432



xii

Part V Specifying and interpreting models: four case studies

Chapter 14	Case studies 1 and 2: unemployment in Britain and emigration	
-	from Ireland	437
14.1	Inter-war benefits and unemployment in Great Britain	438
	14.1.1 The Benjamin and Kochin model	438
	14.1.2 Parameter stability and outliers in the Benjamin and	
	Kochin model	440
14.2	Emigration from Ireland	445
	14.2.1 The time-series model of Irish emigration	446
	14.2.2 The panel model of Irish emigration	451
	14.2.3 The impact of the explanatory variables on changes in	
	emigration over time	458
Chapter 15	Case studies 3 and 4: the Old Poor Law in England and leaving hom	ne
	in the United States, 1850–1860	463
15.1	The effects of the Old Poor Law	463
	15.1.1 Relief payments, wages, and unemployment	464
· *	15.1.2 The Old Poor Law and the birth rate	476
15.2	Leaving home in the United States, 1850–1860	480
	15.2.1 Influences on leaving home	482
	15.2.2 The logit model	483
Appendix to \$15.1.1	Derivation of reduced-form equations from a simultaneous-	
	equations model	491
Appendix A	The four data sets	496
A.1	The iniquitous effects of the Old Poor Law	496
A.2	What explains the scale and timing of the massive emigration from	
	Ireland after the famine?	497
A.3	To what extent were generous unemployment benefits responsible	
	for the high level of unemployment in inter-war Britain?	501
A.4	What influenced children's decision to leave home in the United	
	States in the mid-nineteenth century?	502
Appendix B	Index numbers	507
B.1	Price and quantity relatives	507
B.2	Two types of index number	508
B.3	Laspeyres index numbers with fixed weights	510
B.4	The index number problem and chained indices	513
B.5	Paasche index numbers with changing (given year) weights	520
	Bibliography	529
	Index of subjects	539
	Index of names	545