CONTENTS

Acknowledgments Preface					
					nyms
Basi	Basic Tools				
1.1	Goals	of inference	1		
	1.1.1	Population or process?	1		
	1.1.2	Probability samples	2		
	1.1.3	Sampling weights	3		
	1.1.4	Design effects.	5		
1.2	An introduction to the data				
	1.2.1	Real surveys	6		
	1.2.2	Populations	8		
1.3	Obtain	ing the software	9		
	1.3.1	Obtaining R	9		
	1.3.2	Obtaining the survey package	10		
1.4	Using	R	10		
	Basi 1.1 1.2	Cee nyms Basic Tools 1.1 Goals of 1.1.1 1.1.2 1.1.3 1.1.4 1.2 An intraction 1.2.1 1.2.2 1.3 Obtain 1.3.1 1.3.2	Basic Tools 1.1 Goals of inference 1.1.1 Population or process? 1.1.2 Probability samples 1.1.3 Sampling weights 1.1.4 Design effects. 1.2 An introduction to the data 1.2.1 Real surveys 1.2.2 Populations 1.3 Obtaining the software 1.3.1 Obtaining R 1.3.2 Obtaining the survey package		

vi	CONTENTS

		1.4.1 Re	eading plain text data	10
		1.4.2 Re	eading data from other packages	12
		1.4.3 Sin	mple computations	12
		Exercises		13
2	Sim	ole and Stra	tified sampling	17
	2.1	Analysing s	simple random samples	17
		2.1.1 Co	onfidence intervals	19
		2.1.2 De	escribing the sample to R	19
	2.2	Stratified sa	ımpling	21
	2.3	Replicate w	reights	23
		2.3.1 Sp	ecifying replicate weights to R	24
		2.3.2 Cr	eating replicate weights in R	25
	2.4	Other popu	lation summaries	27
		2.4.1 Qu	antiles	27
		2.4.2 Co	ontingency tables	28
	2.5	Estimates in	n subpopulations	31
	2.6	Design of s	tratified samples	34
		Exercises		35
3	Clus	ter samplin	g	39
	3.1	Introduction	n	39
		3.1.1 W	hy clusters: the NHANES II design	39
		3.1.2 Sin	ngle-stage and multistage designs	41
	3.2	Describing	multistage designs to R	42
		3.2.1 Str	rata with only one PSU	43
		3.2.2 Ho	ow good is the single-stage approximation?	44
			eplicate weights for multistage samples	44
	3.3	Sampling b		46
			oss of information from sampling clusters	49
	3.4		neasurements	51
		Exercises		54
4	Gra	hics		57
	4.1	Why is surv	vey data different?	57
	4.2	Plotting a ta		58
	4.3	_	uous variable	62
	1.0		raphs based on the distribution function	62

			CONTE	ents vii
		4.3.2	Graphs based on the density	65
	4.4	Two co	ontinuous variables	67
		4.4.1	Scatterplots	67
		4.4.2	Aggregation and smoothing	70
		4.4.3	Scatterplot smoothers	71
	4.5	Condit	ioning plots	72
	4.6	Maps		75
		4.6.1	Design and estimation issues	75
		4.6.2	Drawing maps in R	76
		Exercis	ses	79
5	Ratio	os and I	inear regression	83
	5.1	Ratio e	estimation	84
		5.1.1	Estimating ratios	84
		5.1.2	Ratios for subpopulation estimates	85
		5.1.3	Ratio estimators of totals	85
	5.2	Linear	regression	90
		5.2.1	The least-squares slope as an estimated populatio	n
			summary	90
		5.2.2	Regression estimation of population totals	92
		5.2.3	Confounding and other criteria for model choice	97
		5.2.4	Linear models in the survey package	98
	5.3	Is weig	ghting needed in regression models?	104
		Exercis	ses	105
6	Cate	gorical	data regression	109
	6.1	Logisti	ic regression	110
		6.1.1	Relative risk regression	116
	6.2	Ordina	ıl regression	117
		6.2.1	Other cumulative link models	122
	6.3	Loglin	ear models	122
		6.3.1	Choosing models	124
		6.3.2	Linear association models	128
		Exercis	ses	132
7	Post	-stratific	cation, raking and calibration	135
	7.1	Introdu	action	135
	7.2	Post-st	ratification	136

VIII	CONTENTS

	7.3	Raking		139
	7.4	General	ized raking, GREG estimation, and calibration	141
		7.4.1	Calibration in R	143
	7.5	Basu's e	elephants	149
	7.6	Selectin	g auxiliary variables for non-response	152
		7.6.1	Direct standardization	153
		7.6.2	Standard error estimation	154
		Exercise	es	154
8	Two-	phase s	ampling	157
	8.1	Multista	age and multiphase sampling	157
	8.2	Samplin	ng for stratification	158
	8.3	The cas	e-control design	159
		8.3.1	\star Simulations: efficiency of the design-based estimator	161
		8.3.2	Frequency matching	164
	8.4	Samplin	ng from existing cohorts	164
		8.4.1	Logistic regression	165
		8.4.2	Two-phase case-control designs in R	167
		8.4.3	Survival analysis	170
		8.4.4	Case-cohort designs in R	171
	8.5	Using a	uxiliary information from phase one	174
		8.5.1	Population calibration for regression models	175
		8.5.2	Two-phase designs	178
		8.5.3	Some history of the two-phase calibration estimator	180
		Exercise	es	181
9	Missi	ng data		185
	9.1	Item no	n-response	185
	9.2		ase estimation for missing data	186
		9.2.1	Calibration for item non-response	186
		9.2.2	Models for response probability	189
		9.2.3	Effect on precision	190
		9.2.4	★ Doubly-robust estimators	192
	9.3	Imputat	ion of missing data	193
		9.3.1	Describing multiple imputations to R	195
		9.3.2	Example: NHANES III imputations	196
		Exercise	es	200

			CC	ONTENTS	IX
10	∗ Cau	ısal infe	erence		203
	10.1	IPTW e	estimators		204
		10.1.1	Randomized trials and calibration		204
		10.1.2	Estimated weights for IPTW		207
		10.1.3	Double robustness		210
	10.2	Margina	al Structural Models		211
Appe	endix A	: Analyti	c details		217
	A.1	Asympt	totics		217
		A.1.1	Embedding in an infinite sequence		217
		A.1.2	Asymptotic unbiasedness		218
		A.1.3	Asymptotic normality and consistency		220
	A.2	Varianc	es by linearization		220
	A.3	Tests in	contingency tables		221
	A.4	Multiple	e imputation		223
	A.5	Calibra	tion and estimating functions		224
	A.6	Calibra	tion in randomized trials and ANCOVA		225
Appe	endix B:	Basic R			229
	B.1	Reading	g data		229
		B.1.1	Plain text data		229
	B.2	Data ma	anipulation		230
		B.2.1	Merging		230
		B.2.2	Factors		231
	B.3	Randon	nness		231
	B.4	Method	ls and objects		232
	B.5	* Writing	ng functions		233
		B.5.1	Repetition		234
		B.5.2	Strings		235
Appe	endix C:	Comput	tational details		237
	C.1	Lineariz	zation		237
		C.1.1	Generalized linear models and expected information	ation	238
	C.2	Replica	te weights		238
		C.2.1	Choice of estimators		238
		C.2.2	Hadamard matrices		239
	C.3	Scatterp	plot smoothers		240
	C.4	Quantil	es		240

X CONTENTS

C.5	Bug reports and feature requests	242
Appendix I	D: Database-backed design objects	243
D.1	Large data	243
D.2	Setting up database interfaces	245
	D.2.1 ODBC	245
	D.2.2 DBI	246
Appendix I	E: Extending the survey package	247
E.1	A case study: negative binomial regression	247
E.2	Using a Poisson model	248
E.3	Replicate weights	249
E.4	Linearization	251
References		255
Author Inde	ex	266
Topic Index	C	269