Probability Theory and Statistical Inference

Econometric Modeling with Observational Data

Aris Spanos





Contents

	Pref	ace	page xi
		nowledgments	xxiv
1	An i	ntroduction to empirical modeling	1
	1.1	Introduction	1
	1.2	Stochastic phenomena, a preliminary view	3
	1.3	Chance regularity and statistical models	13
	1.4	Statistical adequacy	16
	1.5	Statistical versus theory information*	19
	1.6	Observed data	20
	1.7	Looking ahead	29
	1.8	Exercises	30
2	Proł	pability theory: a modeling framework	31
	2.1	Introduction	31
	2.2	Simple statistical model: a preliminary view	33
	2.3	Probability theory: an introduction	39
	2.4	Random experiments	42
	2.5	Formalizing condition [a]: the outcomes set	45
	2.6	Formalizing condition [b]: events and probabilities	48
	2.7	Formalizing condition [c]: random trials	69
	2.8	Statistical space	73
	2.9	A look forward	74
	2.10	Exercises	75
3	The notion of a probability model		77
	3.1	Introduction	77
	3.2	The notion of a simple random variable	78
	3.3	The general notion of a random variable	85
	3.4	The cumulative distribution and density functions	89

	3.5 From a probability space to a probability model	97	
	3.6 Parameters and moments	104	
	3.7 Moments	109	
	3.8 Inequalities	131	
	3.9 Summary	132	
	3.10 Exercises	133	
	Appendix A Univariate probability models	135	
	A.1 Discrete univariate distributions	136	
	A.2 Continuous univariate distributions	138	
4	The notion of a random sample	145	
	4.1 Introduction	145	
	4.2 Joint distributions	147	
	4.3 Marginal distributions	155	
	4.4 Conditional distributions	158	
	4.5 Independence	167	
	4.6 Identical distributions	171	
	4.7 A simple statistical model in empirical modeling: a preliminary view		
	4.8 Ordered random samples*	181	
	4.9 Summary	184	
	4.10 Exercises	184	
	Appendix B Bivariate distributions	185	
	B.1 Discrete bivariate distributions	185	
	B.2 Continuous bivariate distributions	186	
5	Probabilistic concepts and real data	190	
	5.1 Introduction	190	
	5.2 Early developments	193	
	5.3 Graphic displays: a <i>t</i> -plot	195	
	5.4 Assessing distribution assumptions	197	
	5.5 Independence and the <i>t</i> -plot	212	
	5.6 Homogeneity and the <i>t</i> -plot	217	
	5.7 The empirical cdf and related graphs*	229	
	5.8 Generating pseudo-random numbers*	254	
	5.9 Summary	258	
	5.10 Exercises	259	
6	The notion of a non-random sample		
	6.1 Introduction	260	
	6.2 Non-random sample: a preliminary view	263	
	6.3 Dependence between two random variables: joint distributions	269	
	6.4 Dependence between two random variables: moments	272	
	6.5 Dependence and the measurement system	282	
	6.6 Joint distributions and dependence	290	

C

	6.7	From probabilistic concepts to observed data	309
	6.8	What comes next?	330
	6.9	Exercises	335
7	Regi	ression and related notions	337
	7.1	Introduction	337
	7.2	Conditioning and regression	339
	7.3	Reduction and stochastic conditioning	356
	7.4	Weak exogeneity*	366
	7.5	The notion of a statistical generating mechanism (GM)	368
	7.6	The biometric tradition in statistics	377
	7.7	Summary	397
	7.8	Exercises	397
8	Stoc	hastic processes	400
	8.1	Introduction	400
	8.2	The notion of a stochastic process	403
	8.3	Stochastic processes: a preliminary view	410
	8.4	Dependence restrictions	420
	8.5	Homogeneity restrictions	426
	8.6	"Building block" stochastic processes	431
	8.7	Markov processes	433
	8.8	Random walk processes	435
	8.9	Martingale processes	438
		Gaussian processes	444
		Point processes	458
	8.12	Exercises	460
9		it theorems	462
	9.1	Introduction to limit theorems	462
	9.2	Tracing the roots of limit theorems	465
	9.3	The Weak Law of Large Numbers	469
	9.4	The Strong Law of Large Numbers	476
	9.5	The Law of Iterated Logarithm*	481
	9.6	The Central Limit Theorem	482
	9.7	Extending the limit theorems*	491
	9.8	Functional Central Limit Theorem*	495
	9.9	Modes of convergence	503
		Summary and conclusion	510
	9.11	Exercises	510
10		n probability theory to statistical inference*	512
		Introduction	512
	10.2	Interpretations of probability	514

	10.3 Attempts to build a bridge between probability and observed data	520
	10.4 Toward a tentative bridge	528
	10.5 The probabilistic reduction approach to specification	541
	10.6 Parametric versus non-parametric models	546
	10.7 Summary and conclusions	556
	10.8 Exercises	556
11	An introduction to statistical inference	558
	11.1 Introduction	558
	11.2 An introduction to the classical approach	559
	11.3 The classical versus the Bayesian approach	568
	11.4 Experimental versus observational data	570
	11.5 Neglected facets of statistical inference	575
	11.6 Sampling distributions	578
	11.7 Functions of random variables	584
	11.8 Computer intensive techniques for approximating sampling	
	distributions*	594
	11.9 Exercises	600
12	Estimation I: Properties of estimators	602
	12.1 Introduction	602
	12.2 Defining an estimator	603
	12.3 Finite sample properties	607
	12.4 Asymptotic properties	615
	12.5 The simple Normal model	621
	12.6 Sufficient statistics and optimal estimators*	627
	12.7 What comes next?	635
	12.8 Exercises	635
13	Estimation II: Methods of estimation	637
	13.1 Introduction	637
	13.2 Moment matching principle	639
	13.3 The least-squares method	648
	13.4 The method of moments	654
	13.5 The maximum likelihood method	659
	13.6 Exercises	678
14	Hypothesis testing	681
	14.1 Introduction	681
	14.2 Leading up to the Fisher approach	682
	14.3 The Neyman-Pearson framework	692
	14.4 Asymptotic test procedures*	713
	14.5 Fisher versus Neyman–Pearson	720

c

		Contents	ix
	14.6 Conclusion		727
	14.7 Exercises		727
15	Misspecification testing		729
	15.1 Introduction		729
	15.2 Misspecification testing: formulating the problem		733
	15.3 A smorgasbord of misspecification tests		739
	15.4 The probabilistic reduction approach and misspecificati	on	753
	15.5 Empirical examples		765
	15.6 Conclusion		783
	15.7 Exercises		784
	References		787
	Index		806

-