

Contents

<i>List of figures</i>	page ix
<i>Acknowledgement</i>	x
<i>Preface</i>	xi
<i>Notation and conventions</i>	xiv
<i>List of abbreviations</i>	xv
1 Introduction	1
1.1 The nature of time series	1
1.2 Explanatory variables and intervention analysis	4
1.3 Multivariate models	7
1.4 Statistical treatment	10
1.5 Modelling methodology	11
1.6 Forecasting	14
1.7 Computer software	15
2 Univariate time series models	17
2.1 Introduction	18
2.2 <i>Ad hoc</i> forecasting procedures	23
2.3 The structure of time series models	31
2.4 Stochastic properties	49
2.5 ARIMA models and the reduced form	65
2.6 ARIMA modelling	75
2.7 Applications	81
<i>Exercises</i>	99
3 State space models and the Kalman filter	100
3.1 The state space form	100
3.2 The Kalman filter	104
3.3 Properties of time-invariant models	113
3.4 Maximum likelihood estimation and the prediction error decomposition	125
	v

vi	Contents	
3.5	Prediction	147
3.6	Smoothing	149
3.7	Non-linearity and non-normality	155
	Appendix. Properties of the multivariate normal distribution	165
	<i>Exercises</i>	166
4	Estimation, prediction and smoothing for univariate structural time series models	168
4.1	Application of the Kalman filter	168
4.2	Estimation in the time domain	180
4.3	Estimation in the frequency domain	191
4.4	Identifiability	205
4.5	Properties of estimators	209
4.6	Prediction	222
4.7	Estimation of components	226
	<i>Exercises</i>	232
5	Testing and model selection	234
5.1	Principles of testing	234
5.2	Lagrange multiplier tests	239
5.3	Tests of specification for structural models	248
5.4	Diagnostics	256
5.5	Goodness of fit	263
5.6	Post-sample predictive testing and model evaluation	270
5.7	Strategy for model selection	273
	<i>Exercises</i>	281
6	Extensions of the univariate model	283
6.1	Trends, detrending and unit roots	283
6.2	Seasonality and seasonal adjustment	300
6.3	Different timing intervals for the model and observations	309
6.4	Data irregularities	326
6.5	Time-varying and non-linear models	341
6.6	Non-normality, count data and qualitative observations	348
	<i>Exercises</i>	362
7	Explanatory variables	365
7.1	Introduction	365
7.2	Estimation in the frequency domain	376

7.3 Estimation of models with explanatory variables and structural time series components	381
7.4 Tests and measures of goodness of fit	385
7.5 Model selection strategy and applications	390
7.6 Intervention analysis	397
7.7 Time-varying parameters	408
7.8 Instrumental variables	411
7.9 Count data	418
<i>Exercises</i>	422

8 Multivariate models 423

8.1 Stochastic properties of multivariate models	423
8.2 Seemingly unrelated time series equations	429
8.3 Homogeneous systems	435
8.4 Testing and model selection	442
8.5 Dynamic factor analysis	449
8.6 Intervention analysis with control groups	456
8.7 Missing observations, delayed observations and contemporaneous aggregation	463
8.8 Vector autoregressive models	468
8.9 Simultaneous equation models	474
<i>Exercises</i>	477

9 Continuous time 479

9.1 Introduction	480
9.2 Stock variables	486
9.3 Flow variables	492
9.4 Multivariate models	501

Appendix 1 Principal structural time series components and models 510

Appendix 2 Data sets 512

A. Energy demand of Other Final Users	512
B. US Real Gross National Product	515
C. Purses snatched in Hyde Park area of Chicago	516
D. Rainfall in Fortaleza, north-east Brazil	517
E. International airline passengers	518
F. Deaths and serious injuries in road accidents, Great Britain	519
G. Tractors in Spain	523
H. Goals scored by England against Scotland in international football matches	524

Cambridge University Press

0521405734 - Forecasting, Structural Time Series Models and the Kalman Filter - Andrew C. Harvey

Table of Contents

[More information](#)viii **Contents**

I. Employment and output in UK manufacturing	525
J. Mink and muskrat furs sold by Hudson's Bay Company	526
<i>Selected answers to exercises</i>	527
<i>References</i>	529
<i>Author, index</i>	543
<i>Subject index</i>	547