Introductory Econometrics for Finance

SECOND EDITION

Chris Brooks The ICMA Centre, University of Reading



UNIVERSITY PRESS

,

Contents

	List of figures	<i>page</i> xii	
	list of tables	xiv	
	List of boxes	xvi	
	List of screenshots	xvii	
	Preface to the second edition	xix	
	Acknowledgements	xxiv	
1	Introduction	1	
1.1	What is econometrics?	1	
1.2	Is financial econometrics different from 'economic econometrics?	2	
1.3	Types of data	3	
1.4	Returns in financial modelling	7	
1.5	Steps involved in formulating an econometric model	9	
1.6	Points to consider when reading articles in empirical finance	10	
1.7	Econometric packages for modelling financial data	11	
1.8	Outline of the remainder of this book	22	
1.9	Further reading	25	
	Appendix: Econometric software package suppliers	26	
2	A brief overview of the classical linear regression model	27	
2.1	What is a regression model?	27	
2.2	Regression versus correlation	28	
2.3	Simple regression	28	
2.4	Some further terminology	37	
2.5	Simple linear regression in EViews - estimation of an optimal		
	hedge ratio	40	
2.6	The assumptions underlying the classical linear regression model	43	
2.7	Properties of the OLS estimator	44	
2.8	Precision and standard errors	46	
2.9	An introduction to statistical inference	51	

Contents

2.10	A special type of hypothesis test: the t-ratio	65
2.11	An example of the use of a simple t-test to test a theory in finance:	
	can US mutual funds beat the market?	67
2.12	Can UK unit trust managers beat the market?	69
2.13	The overreaction hypothesis and the UK stock market	71
2.14	The exact significance level	74
2.15	Hypothesis testing in EViews - example 1: hedging revisited	75
2.16	Estimation and hypothesis testing in EViews - example 2:	
	the CAPM	77
	Appendix: Mathematical derivations of CLRM results	81
3	Further development and analysis of the classical linear	
	regression model	88
3.1	Generalising the simple model to multiple linear regression	88
3.2	The constant term	89
3.3	How are the parameters (the elements of the $f3$ vector) calculated	
	in the generalised case?	91
3.4	Testing multiple hypotheses: the F-test	93
3.5	Sample EViews output for multiple hypothesis tests	99
3.6	Multiple regression in EViews using an APT-style model	99
3.7	Data mining and the true size of the test	105
3.8	Goodness of fit statistics	106
3.9		112
3.10		115
	Appendix 3.1: Mathematical derivations of CLRM results	117
	Appendix 3.2: A brief introduction to factor models and principal	100
	components analysis	120
4	Classical linear regression model assumptions and	
	diagnostic tests	129
4.1	Introduction	129
4.2	Statistical distributions for diagnostic tests	130
4.3		131
4.4	Assumption 2: $var(\ll) = a^2 < oo$	132
4.5	Assumption 3: COV(M,, UJ) = 0 for / ^ j	139
4.6	Assumption 4: the x, are non-stochastic	160
4.7	Assumption 5: the disturbances are normally distributed	161
4.8	Multicollinearity	170
4.9	Adopting the wrong functional form	174
4.10	Omission of an important variable	178
4.11	Inclusion of an irrelevant variable	179

4.12	Parameter stability tests	180
4.13	A strategy for constructing econometric models and a discussion	
	of model-building philosophies	191
4.14	Determinants of sovereign credit ratings	194
5	Univariate time series modelling and forecasting	206
5.1	Introduction	206
5.2	Some notation and concepts	207
5.3	Moving average processes	211
5.4	Autoregressive processes	215
5.5	The partial autocorrelation function	222
5.6	ARMA processes	223
5.7	Building ARMA models: the Box-Jenkins approach	230
5.8	Constructing ARMA models in EViews	234
5.9	Examples of time series modelling in finance	239
5.10	Exponential smoothing	241
5.11	Forecasting in econometrics	243
5.12	Forecasting using ARMA models in EViews	256
5.13	Estimating exponential smoothing models using EViews	258
6	Multivariate models	265
6.1	Motivations	265
6.2	Simultaneous equations bias	268
6.3	So how can simultaneous equations models be validly estimated?	269
6.4		269
6.5	Simultaneous equations in finance	272
6.6	A definition of exogeneity	273
6.7	Triangular systems	275
6.8	Estimation procedures for simultaneous equations systems	276
6.9	An application of a simultaneous equations approach to	
	modelling bid-ask spreads and trading activity	279
6.10	Simultaneous equations modelling using EViews	285
	Vector autoregressive models	290
6.12		295
6.13	Block significance and causality tests	297
6.14	VARs with exogenous variables	298
6.15	-	298
6.16	VAR model example: the interaction between property returns and	
	the macroeconomy	302
6.17	VAR estimation in EViews	308

\// || - '_| j

7	Modelling long-run relationships in finance	318
7.1	Stationarity and unit root testing	318
7.2	Testing for unit roots in EViews	331
7.3	Cointegration	335
7.4	Equilibrium correction or error correction models	337
7.5	Testing for cointegration in regression: a residuals-based approach	339
7.6	Methods of parameter estimation in cointegrated systems	341
7.7	Lead-lag and long-term relationships between spot and	
	futures markets	343
7.8	Testing for and estimating cointegrating systems using the	
	Johansen technique based on VARs	350
7.9	Purchasing power parity	355
7.10	Cointegration between international bond markets	357
7.11	Testing the expectations hypothesis of the term structure of	
	interest rates	362
7.12	Testing for cointegration and modelling cointegrated systems	
	using EViews	365
8	Modelling volatility and correlation	379
8.1	Motivations: an excursion into non-linearity land	379
8.2	Models for volatility	383
8.3	Historical volatility	383
8.4	Implied volatility models	384
8.5	Exponentially weighted moving average models	384
8.6	Autoregressive volatility models	385
8.7	Autoregressive conditionally heteroscedastic (ARCH) models	386
8.8	Generalised ARCH (GARCH) models	392
8.9	Estimation of ARCH/GARCH models	394
8.10	Extensions to the basic GARCH model	404
8.11	Asymmetric GARCH models	404
8.12	The GJR model	405
8.13	The EGARCH model	406
8.14	GJR and EGARCH in EViews	406
8.15	Tests for asymmetries in volatility	408
8.16	GARCH-in-mean	409
8.17	Uses of GARCH-type models including volatility forecasting	411
8.18	Testing non-linear restrictions or testing hypotheses about	
	non-linear models	417
8.19	Volatility forecasting: some examples and results from the	
	literature	420
8.20	Stochastic volatility models revisited	427

1

8.21	Forecasting covariances and correlations	428
8.22	Covariance modelling and forecasting in finance: some examples	429
8.23	Historical covariance and correlation	431
8.24	Implied covariance models	431
8.25	Exponentially weighted moving average model for covariances	432
8.26	Multivariate GARCH models	432
8.27	A multivariate GARCH model for the CAPM with time-varying	
	covariances	436
8.28	Estimating a time-varying hedge ratio for FTSE stock index returns	437
8.29	Estimating multivariate GARCH models using EViews	441
	Appendix: Parameter estimation using maximum likelihood	444
9	Switching models	451
9.1	Motivations	451
9.2	Seasonalities in financial markets: introduction and	
	literature review	454
9.3	Modelling seasonality in financial data	455
9.4	Estimating simple piecewise linear functions	462
9.5	Markov switching models	464
9.6	A Markov switching model for the real exchange rate	466
9.7	A Markov switching model for the gilt-equity yield ratio	469
9.8	Threshold autoregressive models	473
9.9	Estimation of threshold autoregressive models	474
9.10	Specification tests in the context of Markov switching and	
	threshold autoregressive models: a cautionary note	476
9.11	A SETAR model for the French franc-German mark exchange rate	477
9.12	Threshold models and the dynamics of the FTSE 100 index and	
	index futures markets	480
9.13	A note on regime switching models and forecasting accuracy	484
10	Panel data	487
10.1	Introduction - what are panel techniques and why are they used?	487
10.2	What panel techniques are available?	489
10.3	The fixed effects model	490
10.4		493
10.5		494
10.6		498
10.7		
	Eastern Europe	499
10.8		502
10.9	Further reading	509

Contents

11	Limited dependent variable models	511
11.1	Introduction and motivation	511
11.2	The linear probability model	512
11.3	The logit model	514
11.4	Using a logit to test the pecking order hypothesis	515
11.5	The probit model	517
11.6	Choosing between the logit and probit models	518
11.7	Estimation of limited dependent variable models	518
11.8	Goodness of fit measures for linear dependent variable models	519
11.9	Multinomial linear dependent variables	521
11.10	The pecking order hypothesis revisited - the choice between	
	financing methods	525
11.11	Ordered response linear dependent variables models	527
11.12	Are unsolicited credit ratings biased downwards? An ordered	
	probit analysis	528
11.13	Censored and truncated dependent variables	533
11.14	Limited dependent variable models in EViews	537
	Appendix: The maximum likelihood estimator for logit and	
	probit models	544
12	Simulation methods	546
12.1	Motivations	546
12.2	Monte Carlo simulations	547
12.3	Variance reduction techniques	549
12.4	Bootstrapping	553
12.5	Random number generation	557
12.6	Disadvantages of the simulation approach to econometric or	
	financial problem solving	558
12.7	An example of Monte Carlo simulation in econometrics: deriving a	
	set of critical values for a Dickey-Fuller test	559
12.8	An example of how to simulate the price of a financial option	565
12.9	An example of bootstrapping to calculate capital risk requirements	571
13	Conducting empirical research or doing a project or dissertation	
	in finance	585
13.1	What is an empirical research project and what is it for?	585
13.2	Selecting the topic	586
13.3	Sponsored or independent research?	590
13.4	The research proposal	590
13.5	Working papers and literature on the internet	591
13.6	Getting the data	591

13.7	Choice of computer software	593
13.8	How might the finished project look?	593
13.9	Presentational issues	597
14	Recent and future developments in the modelling	
	of financial time series	598
14.1	Summary of the book	598
14.2	What was not covered in the book	598
14.3	Financial econometrics: the future?	602
14.4	The final word	606
Annondia 4	A review of some fundamental methometical and	
Appendix 1	A review of some fundamental mathematical and statistical concepts	607
Al	Introduction	607
A2	Characteristics of probability distributions	607
A3	Properties of logarithms	608
A4	Differential calculus	609
A5	Matrices	611
A6	The eigenvalues of a matrix	614
Annendix 2	Tables of statistical distributions	616
		010
Appendix 3	Sources of data used in this book	628
	References	629
	Index	641