

Contents

	<i>Page</i>
<i>Preface to the 2nd edition</i>	xv
<i>Preface to the 1st edition</i>	xxv
1 INTRODUCTION	1
1.1 Financial time series	1
1.2 About this study	2
1.3 The world's major financial markets	3
1.4 Examples of daily price series	4
1.5 A selective review of previous research	8
Important questions	8
The random walk hypothesis	8
The efficient market hypothesis	10
1.6 Daily returns	12
1.7 Models	13
1.8 Models in this book	15
1.9 Stochastic processes	16
General remarks	16
Stationary processes	16
Autocorrelation	17
Spectral density	18
White noise	19
ARMA processes	20
Gaussian processes	23
1.10 Linear stochastic processes	23
Their definition	23
Autocorrelation tests	24
2 FEATURES OF FINANCIAL RETURNS	26
2.1 Constructing financial time series	26
Sources	26
Time scales	27
Additional information	27
Using futures contracts	28

2.2	Prices studied	28
	Spot prices	28
	Futures prices	30
	Commodity futures	30
	Financial futures	31
	Extended series	32
2.3	Average returns and risk premia	32
	Annual expected returns	33
	Common stocks and ordinary shares	35
	Spot commodities	36
	Spot currencies	36
	Commodity futures	36
2.4	Standard deviations	38
	Risks compared	39
	Futures and contract age	40
2.5	Calendar effects	41
	Day-of-the-week	41
	Stocks	41
	Currencies	41
	Agricultural futures	42
	Standard deviations	42
	Month-of-the-year effects for stocks	43
2.6	Skewness	44
2.7	Kurtosis	44
2.8	Plausible distributions	45
2.9	Autocorrelation	48
	First-lag	49
	Lags 1 to 30	50
	Tests	50
2.10	Non-linear structure	52
	Not strict white noise	52
	A characteristic of returns	52
	Not linear	56
	Consequences of non-linear structure	57
2.11	Summary	58
	Appendix 2(A) Autocorrelation caused by day-of-the-week effects	58
	Appendix 2(B) Autocorrelations of a squared linear process	60
3	MODELLING PRICE VOLATILITY	62
3.1	Introduction	62
3.2	Elementary variance models	63
	Step change, discrete distributions	63
	Markov variances, discrete distributions	64

	Step variances, continuous distributions	65
	Markov variances, continuous distributions	66
3.3	A general variance model	67
	Notation	69
3.4	Modelling variance jumps	69
3.5	Modelling frequent variance changes not caused by prices	70
	General models	70
	Stationary models	72
	The lognormal, autoregressive model	73
3.6	Modelling frequent variance changes caused by past prices	75
	General concepts	75
	Caused by past squared returns	76
	Caused by past absolute returns	78
	ARMACH models	78
3.7	Modelling autocorrelation and variance changes	79
	Variances not caused by returns	81
	Variances caused by returns	82
3.8	Parameter estimation for variance models	83
3.9	Parameter estimates for product processes	84
	Lognormal AR(1)	86
	Results	88
3.10	Parameter estimates for ARMACH processes	90
	Results	92
3.11	Summary	93
	Appendix 3(A) Results for ARCH processes	95
4	FORECASTING STANDARD DEVIATIONS	97
4.1	Introduction	97
4.2	Key theoretical results	98
	Uncorrelated returns	98
	Correlated returns	100
	Relative mean square errors	100
	Stationary processes	100
4.3	Forecasts: methodology and methods	101
	Benchmark forecast	101
	Parametric forecasts	101
	Product process forecasts	102
	ARMACH forecasts	103
	EWMA forecasts	103
	Futures forecasts	104
	Empirical RMSE	105
4.4	Forecasting results	106
	Absolute returns	106

	Conditional standard deviations	107
	Two leading forecasts	108
	More distant forecasts	108
	Conclusions about stationarity	110
	Another approach	110
4.5	Recommended forecasts for the next day	110
	Examples	113
4.6	Summary	114
5	THE ACCURACY OF AUTOCORRELATION ESTIMATES	116
5.1	Introduction	116
5.2	Extreme examples	117
5.3	A special null hypothesis	118
5.4	Estimates of the variances of sample autocorrelations	119
5.5	Some asymptotic results	120
	Linear processes	121
	Non-linear processes	122
5.6	Interpreting the estimates	123
5.7	The estimates for returns	124
5.8	Accurate autocorrelation estimates	126
	Rescaled returns	127
	Variance estimates for recommended coefficients	128
	Exceptional series	130
5.9	Simulation results	130
5.10	Autocorrelations of rescaled processes	131
5.11	Summary	132
6	TESTING THE RANDOM WALK HYPOTHESIS	133
6.1	Introduction	133
6.2	Test methodology	134
6.3	Distributions of sample autocorrelations	135
	Asymptotic limits	136
	Finite samples	136
6.4	A selection of test statistics	137
	Autocorrelation tests	137
	Spectral tests	138
	The runs test	140
6.5	The price-trend hypothesis	141
	Price-trend autocorrelations	141
	An example	142
	Price-trend spectral density	143
6.6	Tests for random walks versus price-trends	143
6.7	Consequences of data errors	145

6.8	Results of random walk tests	146
	Stocks	150
	Commodities and currencies	152
	About the rest of this chapter	156
6.9	Some test results for returns	157
6.10	Power comparisons	159
6.11	Testing equilibrium models	161
	Stocks	161
	Simulation results	163
	Tests	165
	Other equilibrium models	166
	Conclusion	166
6.12	Institutional effects	167
	Limit rules	167
	Bid–ask spreads	169
6.13	Results for subdivided series	169
6.14	Conclusions	170
6.15	Summary	172
	Appendix 6(A) Correlation between test values for two related series	172
7	FORECASTING TRENDS IN PRICES	174
7.1	Introduction	174
7.2	Price-trend models	174
	A non-linear trend model	176
	A linear trend model	176
7.3	Estimating the trend parameters	178
	Methods	178
	Futures	179
	Spots	181
	Accuracy	183
7.4	Some results from simulations	183
	Estimates	183
	A puzzle solved	185
7.5	Forecasting returns: theoretical results	185
	The next return	186
	More distant returns	187
	Sums of future returns	187
7.6	Empirical forecasting results	188
	Benchmark forecasts	188
	Price-trend forecasts	189
	Summary statistics	189
	Futures	190
	Spots	192

7.7	Further forecasting theory	193
	Expected changes in prices	193
	Forecasting the direction of the trend	194
	Forecasting prices	194
7.8	Summary	194
8	EVIDENCE AGAINST THE EFFICIENCY OF FUTURES MARKETS	196
8.1	Introduction	196
8.2	The efficient market hypothesis	197
8.3	Problems raised by previous studies	199
	Filter rules	199
	Benchmarks	200
	Significance	201
	Optimization	201
8.4	Problems measuring risk and return	201
	Returns	201
	Risk	202
	Necessary assumptions	203
8.5	Trading conditions	203
8.6	Theoretical analysis	204
	Trading strategies	204
	Assumptions	205
	Conditions for trading profits	206
	Inefficient regions	207
	Some implications	209
8.7	Realistic strategies and assumptions	210
	Strategies	211
	Assumptions	212
	Notes on objectives	213
8.8	Trading simulated contracts	213
	Commodities	214
	Currencies	215
8.9	Trading results for futures	216
	Calibration contracts	216
	Test contracts	217
	Portfolio results	222
8.10	Towards conclusions	223
8.11	Summary	224
9	VALUING OPTIONS	225
9.1	Introduction	225
9.2	Black–Scholes option pricing formulae	226
9.3	Evaluating standard formulae	227

9.4	Call values when conditional variances change	228
	Formulae for a stationary process	228
	Examples	230
	Non-stationary processes	233
	Conclusions	233
9.5	Price trends and call values	234
	A formula for trend models	234
	Examples	235
9.6	Summary	237
10	CONCLUDING REMARKS	238
10.1	Price behaviour	238
10.2	Advice to traders	239
10.3	Further research	240
10.4	Stationary models	241
	Random walks	241
	Price trends	242
APPENDIX: A COMPUTER PROGRAM FOR MODELLING FINANCIAL TIME SERIES		243
	Output produced	243
	Computer time required	244
	User-defined parameters	244
	Optional parameters	245
	Input requirements	245
	About the subroutines	247
	FORTRAN program	248
	<i>References</i>	256
	<i>Author index</i>	262
	<i>Subject index</i>	264