Contents

Preface xv

Acknowledgements xvii

Part I: Volatility and Correlation Analysis

Chapter 1: Understanding Volatility and Correlation 3
  1.1 The Statistical Nature of Volatility and Correlation 4
  1.2 Volatility and Correlation in Financial Markets 9
  1.3 Constant and Time-Varying Volatility Models ~" 12
  1.4 Constant and Time-Varying Correlation Models 14
  1.5 Remarks on Implementing Volatility and Correlation Models 17
  1.6 Summary * 18

Chapter 2: Implied Volatility and Correlation 21
  2.1 Understanding Implied Volatility* 22
    2.1.1 Volatility in a Black-Scholes World 23
    2.1.2 Call and Put Implied Volatilities 26
    2.1.3 Differences between Implied and Statistical Volatilities 28
  2.2 Features of Implied Volatility* 30
    2.2.1 Smiles and Skews 30
    2.2.2 Volatility Term Structures 31
    2.2.3 Volatility Surfaces 32
  2.3 The Relationship between Prices and Implied Volatility 34
    2.3.1 Equity Prices and Volatility Regimes - . 34
    2.3.2 Scenario Analysis of Prices and Implied Volatility 38
    2.3.3 Implications for Delta Hedging 43
  2.4 Implied Correlation 45

Chapter 3: Moving Average Models 49
  3.1 Historic Volatility and Correlation* 50
    3.1.1 Definition and Application" 50
    3.1.2 Historic Volatility in Financial Markets 52
    3.1.3 Historic Correlation in Energy Markets" 54
    3.1.4 When and How Should Historic Estimates Be Used? 56

An asterisk ‘*’ denotes that illustrative software is on the CD. The password for the CD is available from http://www.wiley.co.uk/marketmodels.
Chapter 4: GARCH Models

4.1 Introduction to Generalized Autoregressive Conditional Heteroscedasticity
   4.1.1 Volatility Clustering
   4.1.2 The Leverage Effect
   4.1.3 The Conditional Mean and Conditional Variance Equations

4.2 A Survey of Univariate GARCH Models
   4.2.1 ARCH
   4.2.2 Symmetric GARCH*
   4.2.3 Integrated GARCH and the Components Model
   4.2.4 Asymmetric GARCH*
   4.2.5 GARCH Models for High-Frequency Data

4.3 Specification and Estimation of GARCH Models
   4.3.1 Choice of Data, Stability of GARCH Parameters and Long-Term Volatility
   4.3.2 Parameter Estimation Algorithms
   4.3.3 Estimation Problems
   4.3.4 Choosing the Best GARCH Model

4.4 Applications of GARCH Models
   4.4.1 GARCH Volatility Term Structures*
   4.4.2 Option Pricing and Hedging
   4.4.3 Smile Fitting

4.5 Multivariate GARCH
   4.5.1 Time-Varying Correlation
   4.5.2 Multivariate GARCH Parameterizations
   4.5.3 Time-Varying Covariance Matrices Based on Univariate GARCH Models

Chapter 5: Forecasting Volatility and Correlation

5.1 Evaluating the Accuracy of Point Forecasts
   5.1.1 Statistical Criteria
   5.1.2 Operational Criteria

5.2 Confidence Intervals for Volatility Forecasts
   5.2.1 Moving Average Models
   5.2.2 GARCH Models
   5.2.3 Confidence Intervals for Combined Forecasts

5.3 Consequences of Uncertainty in Volatility and Correlation
   5.3.1 Adjustment in Mark-to-Model Value of an Option*
   5.3.2 Uncertainty in Dynamically Hedged Portfolios

Part II: Modelling the Market Risk of Portfolios

Chapter 6: Principal Component Analysis

6.1 Mathematical Background
Contents

6.2 Application to Term Structures*
  6.2.1 The Trend, Tilt and Convexity Components of a Single Yield Curve 147
  6.2.2 Modelling Multiple Yield Curves with PCA 149
  6.2.3 Term Structures of Futures Prices 153
6.3 Modelling Volatility Smiles and Skews
  6.3.1 PCA of Deviations from ATM Volatility 157
  6.3.2 The Dynamics of Fixed Strike Volatilities in Different Market Regimes 159
  6.3.3 Parameterization of the Volatility Surface and Quantification of \( \frac{da}{dS} \) 167
  6.3.4 Summary 170
6.4 Overcoming Data Problems Using PCA
  6.4.1 Multicollinearity 172
  6.4.2 Missing Data 175

Chapter 7: Covariance Matrices 179
7.1 Applications of Covariance Matrices in Risk Management
  7.1.1 The Variance of a Linear Portfolio 180
  7.1.2 Simulating Correlated Risk Factor Movements in Derivatives Portfolios 182
  7.1.3 The Need for Positive Semi-definite Covariance Matrices* 183
  7.1.4 Stress Testing Portfolios Using the Covariance Matrix* 184
7.2 Applications of Covariance Matrices in Investment Analysis 186
  7.2.1 Minimum Variance Portfolios 187
  7.2.2 The Relationship between Risk and Return 189
  7.2.3 Capital Allocation and Risk-Adjusted Performance Measures 193
  7.2.4 Modelling Attitudes to Risk 194
  7.2.5 Efficient Portfolios in Practice 198
7.3 The RiskMetrics Data 201
7.4 Orthogonal Methods for Generating Covariance Matrices
  7.4.1 Using PCA to Construct Covariance Matrices 205
  7.4.2 Orthogonal EWMA 206
  7.4.3 Orthogonal GARCH 210
  7.4.4 'Splicing' Methods for Obtaining Large Covariance Matrices 221
  7.4.5 Summary 227

Chapter 8: Risk Measurement in Factor Models 229
8.1 Decomposing Risk in Factor Models
  8.1.1 The Capital Asset Pricing Model 230
  8.1.2 Multi-factor Fundamental Models 233
  8.1.3 Statistical Factor Models 235
8.2 Classical Risk Measurement Techniques*
  8.2.1 The Different Perspectives of Risk Managers and Asset Managers 236
  8.2.2 Methods Relevant for Constant Parameter Assumptions 237
Contents

10.3 Applications of Normal-Mixture Distributions* 301
10.3.1 Covariance VaR Measures 302
10.3.2 Term Structure Forecasts of Excess Kurtosis 303
10.3.3 Applications of Normal Mixtures to Option Pricing and Hedging 305

Part III: Statistical Models for Financial Markets

Chapter 11: Time Series Models 315
11.1 Basic Properties of Time Series 316
11.1.1 Time Series Operators 316
11.1.2 Stationary Processes and Mean-Reversion 317
11.1.3 Integrated Processes and Random Walks 320
11.1.4 Detrending Financial Time Series Data 322
11.1.5 Unit Root Tests* 324
11.1.6 Testing for the Trend in Financial Markets 328
11.2 Univariate Time Series Models 329
11.2.1 AR Models 329
11.2.2 MA Models 331
11.2.3 ARMA Models 332
11.3 Model Identification* 333
11.3.1 Correlograms 333
11.3.2 Autocorrelation Tests 335
11.3.3 Testing Down 337
11.3.4 Forecasting with ARMA Models 338
11.4 Multivariate Time Series 340
11.4.1 Vector Autoregressions 340
11.4.2 Testing for Joint Covariance Stationarity 341
11.4.3 Granger Causality 344

Chapter 12: Cointegration 347
12.1 Introducing Cointegration 348
12.1.1 Cointegration and Correlation 349
12.1.2 Common Trends and Long-Run Equilibria 350
12.2 Testing for Cointegration* 353
12.2.1 The Engle-Granger Methodology 354
12.2.2 The Johansen Methodology 357
12.3 Error Correction and Causality 361
12.4 Cointegration in Financial Markets 366
12.4.1 Foreign Exchange 366
12.4.2 Spot and Futures 367
12.4.3 Commodities 367
12.4.4 Spread Options 367
12.4.5 Term Structures 368
12.4.6 Market Integration 368
12.5 Applications of Cointegration to Investment Analysis 369
12.5.1 Selection and Allocation 370
<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5.2 Constrained Allocations</td>
</tr>
<tr>
<td>12.5.3 Parameter Selection</td>
</tr>
<tr>
<td>12.5.4 Long-Short Strategies</td>
</tr>
<tr>
<td>12.5.5 Backtesting</td>
</tr>
<tr>
<td>12.6 Common Features</td>
</tr>
<tr>
<td>12.6.1 Common Autocorrelation</td>
</tr>
<tr>
<td>12.6.2 Common Volatility</td>
</tr>
</tbody>
</table>

**Chapter 13: Forecasting High-Frequency Data**

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.1 High-Frequency Data</td>
</tr>
<tr>
<td>13.1.1 Data and Information Sources</td>
</tr>
<tr>
<td>13.1.2 Data Filters</td>
</tr>
<tr>
<td>13.1.3 Autocorrelation Properties</td>
</tr>
<tr>
<td>13.1.4 Parametric Models of High-Frequency Data</td>
</tr>
<tr>
<td>13.2 Neural Networks</td>
</tr>
<tr>
<td>13.2.1 Architecture</td>
</tr>
<tr>
<td>13.2.2 Data Processing</td>
</tr>
<tr>
<td>13.2.3 Backpropagation</td>
</tr>
<tr>
<td>13.2.4 Performance Measurement</td>
</tr>
<tr>
<td>13.2.5 Integration</td>
</tr>
<tr>
<td>13.3 Price Prediction Models Based on Chaotic Dynamics</td>
</tr>
<tr>
<td>13.3.1 Testing for Chaos</td>
</tr>
<tr>
<td>13.3.2 Nearest Neighbour Algorithms</td>
</tr>
<tr>
<td>13.3.3 Multivariate Embedding Methods</td>
</tr>
</tbody>
</table>

**Technical Appendices**

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 Linear Regression*</td>
</tr>
<tr>
<td>A. 1.1 The Simple Linear Model</td>
</tr>
<tr>
<td>A. 1.2 Multivariate Models</td>
</tr>
<tr>
<td>A. 1.3 Properties of OLS Estimators</td>
</tr>
<tr>
<td>A. 1.4 Estimating the Covariance Matrix of the OLS Estimators</td>
</tr>
<tr>
<td>A.2 Statistical Inference</td>
</tr>
<tr>
<td>A.2.1 Hypothesis Testing and Confidence Intervals</td>
</tr>
<tr>
<td>A.2.2 Mests</td>
</tr>
<tr>
<td>A.2.3 &quot;-test</td>
</tr>
<tr>
<td>A.2.4 The Analysis of Variance</td>
</tr>
<tr>
<td>A.2.5 Wald, Lagrange Multiplier and Likelihood Ratio Tests</td>
</tr>
<tr>
<td>A.3 Residual Analysis</td>
</tr>
<tr>
<td>A.3.1 Autocorrelation</td>
</tr>
<tr>
<td>A.3.2 Unconditional Heteroscedasticity</td>
</tr>
<tr>
<td>A.3.3 Generalized Least Squares</td>
</tr>
<tr>
<td>A.4 Data Problems</td>
</tr>
<tr>
<td>A.4.1 Multicollinearity</td>
</tr>
<tr>
<td>A.4.2 Data Errors</td>
</tr>
<tr>
<td>A.4.3 Missing Data</td>
</tr>
<tr>
<td>A.4.4 Dummy Variables</td>
</tr>
</tbody>
</table>
Contents

A.5 Prediction 443
  A.5.1 Point Predictions and Confidence Intervals 443
  A.5.2 Backtesting 444
  A.5.3 Statistical and Operational Evaluation Methods 445
A.6 Maximum Likelihood Methods 447
  A.6.1 The Likelihood Function, MLE and LR Tests 447
  A.6.2 Properties of Maximum Likelihood Estimators 449
  A.6.3 MLEs for a Normal Density Function 449
  A.6.4 MLEs for Non-normal Density Functions 451

References 453

Tables 467

Index 475
There are 4 basic market models: pure competition, monopolistic competition, oligopoly, and pure monopoly. Because market competition among the last 3 categories is limited, these market models are often referred to as imperfect competition. In a purely competitive market, there are large numbers of firms producing a standardized product. Market prices are determined by consumer demand; no supplier has any influence over the market price, and thus, the suppliers are often referred to as price takers. Popular Market 3D models. View all. No results. Downloadable. chinese house. 887 Views 1 Comment. 63 Like Unlike. A Medieval market asset pack (Medieval Empire). 6 Views 0 Comment. 3 Like Unlike. Thanks! Also share? Downloadable. Spice stall / Sleeping Dogs Universe. Pure Monopoly models are where a single product or maker controls the market. There are no competitors, and the provider can theoretically drive up prices as they like. Examples of pure monopolies include entities like utility companies and government-run liquor stores.