The Economics of Financial Markets

The Economics of Financial Markets presents a concise overview of capital markets, suitable for advanced undergraduates and for embarking graduate students in financial economics. Following a brief overview of financial markets – their microstructure and the randomness of stock market prices – this textbook explores how the economics of uncertainty can be applied to financial decision making. The mean-variance model of portfolio selection is discussed in detail, with analysis extended to the capital asset pricing model (CAPM). Arbitrage plays a pivotal role in finance and is studied in a variety of contexts, including the arbitrage pricing theory (APT) model of asset prices. Methods for the empirical evaluation of the CAPM and APT are also discussed, together with the volatility of asset prices, the intertemporal CAPM and the equity premium puzzle. An analysis of bond contracts leads into an assessment of theories of the term structure of interest rates. Finally, financial derivatives are explored, focusing on futures and options contracts.

Roy E. Bailey is a Reader in Economics at the University of Essex.
The Economics of Financial Markets

Roy E. Bailey
The Theory of Economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking, which helps its possessor to draw correct conclusions. It is not difficult in the sense in which mathematical and scientific techniques are difficult; but the fact that its modes of expression are much less precise than these, renders decidedly difficult the task of conveying it correctly to the minds of learners.

J. M. Keynes

When you set out for distant Ithaca, fervently wish your journey may be long, – full of adventures and with much to learn.

C. P. Cavafy
Contents in brief

Contents
List of Figures  xv
Preface xvii

1 Asset markets and asset prices  1
2 Asset market microstructure  33
3 Predictability of prices and market efficiency  56
4 Decision making under uncertainty  83
5 Portfolio selection: the mean-variance model  114
6 The capital asset pricing model  143
7 Arbitrage  166
8 Factor models and the arbitrage pricing theory  183
9 Empirical appraisal of the CAPM and APT  200
10 Present value relationships and price variability  222
11 Intertemporal choice and the equity premium puzzle  250
12 Bond markets and fixed-interest securities  281
13 Term structure of interest rates  306
14 Futures markets I: fundamentals  336
15 Futures markets II: speculation and hedging  363
16 Futures markets III: applications  393
17 Swap contracts and swap markets  417
18 Options markets I: fundamentals  438
19 Options markets II: price determination  467
20 Options markets III: applications  494
# Contents

<table>
<thead>
<tr>
<th>List of figures</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>xv</td>
</tr>
</tbody>
</table>

## 1 Asset markets and asset prices

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Capital markets</td>
<td>2</td>
</tr>
<tr>
<td>1.2 Asset price determination: an introduction</td>
<td>5</td>
</tr>
<tr>
<td>1.3 The role of expectations</td>
<td>9</td>
</tr>
<tr>
<td>1.4 Performance risk, margins and short-selling</td>
<td>11</td>
</tr>
<tr>
<td>1.5 Arbitrage</td>
<td>15</td>
</tr>
<tr>
<td>1.6 The role of time</td>
<td>20</td>
</tr>
<tr>
<td>1.7 Asset market efficiency</td>
<td>22</td>
</tr>
<tr>
<td>1.8 Summary</td>
<td>23</td>
</tr>
<tr>
<td>Appendix 1.1: Averages and indexes of stock prices</td>
<td>24</td>
</tr>
<tr>
<td>Appendix 1.2: Real rates of return</td>
<td>28</td>
</tr>
<tr>
<td>Appendix 1.3: Continuous compounding and the force of interest</td>
<td>29</td>
</tr>
</tbody>
</table>

## 2 Asset market microstructure

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Financial markets: functions and participants</td>
<td>34</td>
</tr>
<tr>
<td>2.2 Trading mechanisms</td>
<td>36</td>
</tr>
<tr>
<td>2.3 Industrial organization of financial markets</td>
<td>41</td>
</tr>
<tr>
<td>2.4 Trading and asset prices in a call market</td>
<td>45</td>
</tr>
<tr>
<td>2.5 Bid–ask spreads: inventory-based models</td>
<td>48</td>
</tr>
<tr>
<td>2.6 Bid–ask spreads: information-based models</td>
<td>49</td>
</tr>
<tr>
<td>2.7 Summary</td>
<td>52</td>
</tr>
</tbody>
</table>

## References

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>54</td>
</tr>
</tbody>
</table>
3 Predictability of prices and market efficiency

3.1 Using the past to predict the future 57
3.2 Informational efficiency 64
3.3 Patterns of information 70
3.4 Asset market anomalies 72
3.5 Event studies 75
3.6 Summary 77

Appendix 3.1: The law of iterated expectations and martingales 79

References 81

4 Decision making under uncertainty

4.1 The state-preference approach 85
4.2 The expected utility hypothesis 90
4.3 Behavioural alternatives to the EUH 98
4.4 The mean-variance model 101
4.5 Summary 105

Appendix 4.1: Useful notation 107
Appendix 4.2: Derivation of the FVR 108
Appendix 4.3: Implications of complete asset markets 109
Appendix 4.4: Quadratic von Neumann–Morgenstern utility 110
Appendix 4.5: The FVR in the mean-variance model 111

References 112

5 Portfolio selection: the mean-variance model

5.1 Mean-variance analysis: concepts and notation 115
5.2 Portfolio frontier: two risky assets 118
5.3 Portfolio frontier: many risky assets and no risk-free asset 121
5.4 Portfolio frontier: many risky assets with a risk-free asset 125
5.5 Optimal portfolio selection in the mean-variance model 131
5.6 Summary 133

Appendix 5.1: Numerical example: two risky assets 134
Appendix 5.2: Variance minimization: risky assets only 135
Appendix 5.3: Variance minimization with a risk-free asset 139
Appendix 5.4: Derivation of $\Delta \sigma_P = \beta_{jP} \sigma_P \Delta a_j$ 140
Appendix 5.5: The optimal portfolio with a single risky asset 141

References 142
**Contents**

6 **The capital asset pricing model**  
6.1 Assumptions of the CAPM 144  
6.2 Asset market equilibrium 145  
6.3 The characteristic line and the market model 149  
6.4 The security market line 151  
6.5 Risk premia and diversification 154  
6.6 Extensions 157  
6.7 Summary 159  
Appendix 6.1: The CAPM in terms of asset prices 160  
Appendix 6.2: Linear dependence of $\epsilon_j$ in the CAPM 162  
Appendix 6.3: The CAPM when all assets are risky 162  
References 165

7 **Arbitrage**  
7.1 Arbitrage in theory and practice 166  
7.2 Arbitrage in an uncertain world 168  
7.3 State prices and the risk-neutral valuation relationship 173  
7.4 Summary 176  
Appendix 7.1: Implications of the arbitrage principle 177  
References 182

8 **Factor models and the arbitrage pricing theory**  
8.1 Factor models 184  
8.2 APT 187  
8.3 Predictions of the APT 190  
8.4 Summary 194  
Appendix 8.1: The APT in a multifactor model 195  
Appendix 8.2: The APT in an exact single-factor model 197  
References 199

9 **Empirical appraisal of the CAPM and APT**  
9.1 The CAPM 201  
9.2 Tests of the CAPM: time series 202  
9.3 Tests of the CAPM: cross-sections 206  
9.4 Sharpe ratios and Roll’s criticism 214  
9.5 Multiple-factor models and the APT 215  
9.6 Summary 219  
Appendix 9.1: The Black CAPM in terms of excess returns 220  
References 221

10 **Present value relationships and price variability**  
10.1 Net present value 223  
10.2 Asset price volatility 228
<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.3 Behavioural finance, noise trading and models of dividend growth</td>
<td>235</td>
</tr>
<tr>
<td>10.4 Extreme asset price fluctuations</td>
<td>237</td>
</tr>
<tr>
<td>10.5 Summary</td>
<td>243</td>
</tr>
<tr>
<td>Appendix 10.1: Present values in continuous time</td>
<td>245</td>
</tr>
<tr>
<td>Appendix 10.2: Infinitely lived assets: constant growth</td>
<td>246</td>
</tr>
<tr>
<td>Appendix 10.3: The RNVR with multiple time periods</td>
<td>246</td>
</tr>
<tr>
<td>References</td>
<td>248</td>
</tr>
<tr>
<td>11 Intertemporal choice and the equity premium puzzle</td>
<td>250</td>
</tr>
<tr>
<td>11.1 Consumption and investment in a two-period world with certainty</td>
<td>251</td>
</tr>
<tr>
<td>11.2 Uncertainty, multiple assets and long time horizons</td>
<td>254</td>
</tr>
<tr>
<td>11.3 Lifetime portfolio selection</td>
<td>258</td>
</tr>
<tr>
<td>11.4 The equity premium puzzle and the risk-free rate puzzle</td>
<td>262</td>
</tr>
<tr>
<td>11.5 Intertemporal capital asset pricing models</td>
<td>269</td>
</tr>
<tr>
<td>11.6 Summary</td>
<td>273</td>
</tr>
<tr>
<td>Appendix 11.1: Intertemporal consumption and portfolio selection</td>
<td>274</td>
</tr>
<tr>
<td>Appendix 11.2: Simplifying the FVR</td>
<td>276</td>
</tr>
<tr>
<td>Appendix 11.3: The consumption CAPM</td>
<td>278</td>
</tr>
<tr>
<td>References</td>
<td>280</td>
</tr>
<tr>
<td>12 Bond markets and fixed-interest securities</td>
<td>281</td>
</tr>
<tr>
<td>12.1 What defines a bond?</td>
<td>282</td>
</tr>
<tr>
<td>12.2 Zero-coupon bonds</td>
<td>286</td>
</tr>
<tr>
<td>12.3 Coupon-paying bonds</td>
<td>291</td>
</tr>
<tr>
<td>12.4 Bond valuation</td>
<td>295</td>
</tr>
<tr>
<td>12.5 Risks in bond portfolios</td>
<td>297</td>
</tr>
<tr>
<td>12.6 Immunization of bond portfolios</td>
<td>298</td>
</tr>
<tr>
<td>12.7 Summary</td>
<td>300</td>
</tr>
<tr>
<td>Appendix 12.1: Some algebra of bond yields</td>
<td>302</td>
</tr>
<tr>
<td>References</td>
<td>305</td>
</tr>
<tr>
<td>13 Term structure of interest rates</td>
<td>306</td>
</tr>
<tr>
<td>13.1 Yield curves</td>
<td>307</td>
</tr>
<tr>
<td>13.2 Index-linked bonds</td>
<td>310</td>
</tr>
<tr>
<td>13.3 Implicit forward rates</td>
<td>313</td>
</tr>
<tr>
<td>13.4 The expectations hypothesis of the term structure</td>
<td>317</td>
</tr>
<tr>
<td>13.5 Allowing for risk preferences in the term structure</td>
<td>322</td>
</tr>
<tr>
<td>13.6 Arbitrage and the term structure</td>
<td>326</td>
</tr>
<tr>
<td>13.7 Summary</td>
<td>328</td>
</tr>
</tbody>
</table>
Appendix 13.1: The expectations hypothesis with explicit uncertainty 329
Appendix 13.2: Risk aversion and bond portfolios 331
References 334

14 Futures markets I: fundamentals 336
14.1 Forward contracts and futures contracts 337
14.2 The operation of futures markets 342
14.3 Arbitrage between spot and forward prices 349
14.4 Arbitrage in foreign exchange markets 354
14.5 Repo markets 355
14.6 Summary and conclusion 357
Appendix 14.1: Forward and futures prices 359
Appendix 14.2: Revaluation of a forward contract 360
References 362

15 Futures markets II: speculation and hedging 363
15.1 Speculation 363
15.2 Hedging strategies 365
15.3 Optimal hedging 374
15.4 Theories of futures prices 378
15.5 Manipulation of futures markets 383
15.6 Summary 386
Appendix 15.1: Futures investment as portfolio selection 387
Appendix 15.2: Derivation of $\tilde{h}$ 390
References 392

16 Futures markets III: applications 393
16.1 Weather futures 393
16.2 Financial futures contracts 397
16.3 Short-term interest rate futures 400
16.4 Long-term interest rate, or bond, futures 404
16.5 Stock index futures 406
16.6 The fall of Barings Bank 412
16.7 Summary 414
References 416

17 Swap contracts and swap markets 417
17.1 Swap agreements: the fundamentals 417
17.2 Why do swaps occur? 423
17.3 Risks associated with swaps 429
17.4 Valuation of swaps 429
# Contents

17.5 Metallgesellschaft: a case study 431  
17.6 Summary 435  
References 437  

18 Options markets I: fundamentals 438  
18.1 Call options and put options 439  
18.2 Varieties of options 446  
18.3 Option-like assets 448  
18.4 Upper and lower bounds for option prices 449  
18.5 Put-call parity for European options 454  
18.6 The Modigliani–Miller theorem 457  
18.7 Summary 459  
Appendix 18.1: Lower bound for a European call option premium 460  
Appendix 18.2: Lower bound for a European put option premium 461  
Appendix 18.3: Put-call parity for European options 462  
Appendix 18.4: The Modigliani–Miller theorem: a proof 463  
References 466  

19 Options markets II: price determination 467  
19.1 The fundamentals of option price models 468  
19.2 A two-state option-pricing model 471  
19.3 The Black–Scholes model 480  
19.4 Contingent claims analysis 486  
19.5 Summary 490  
References 492  

20 Options markets III: applications 494  
20.1 Stock index options 495  
20.2 Options on futures contracts 496  
20.3 Interest rate options 500  
20.4 Options and portfolio risks 504  
20.5 Portfolio insurance 507  
20.6 Combinations and spreads 512  
20.7 Summary 514  
Appendix 20.1: Put-call parity for European options on futures 515  
References 518  

Subject index 519  
Author index 526
Figures

1.1 Market equilibrium for a single asset 6
2.1 Flow demand and supply for a single asset 37
3.1 A method for appraising asset market efficiency 67
4.1 States in a two-period world 87
4.2 The value function, z(W), in prospect theory 100
4.3 Indifference curves in $\mu_P$, $\sigma_P$ space 104
5.1 The efficiency frontier with two assets 119
5.2 The efficiency frontier with two assets and $\rho_{12} = \pm 1$ 119
5.3 The efficiency frontier allowing for short-sales 120
5.4 The efficiency frontier with three assets 122
5.5 Efficient portfolios with a risk-free asset 126
5.6 Efficient portfolios with different lending and borrowing rates 128
5.7 The Sharpe ratio and risk-adjusted performance 131
5.8 Optimal portfolio selection 132
5.9 The portfolio frontier with risky assets 137
6.1 The capital market line 147
6.2 The characteristic line for asset $j$ 150
6.3 The security market line 152
6.4 Disequilibrium in the CAPM 153
6.5 Zero-beta portfolios 158
8.1 A single-factor model 185
8.2 The APT in a single-factor model 191
9.1 A test of the CAPM 208
10.1 Observed US stock prices, $\tilde{p}_t$, and ex post rational prices, $\tilde{p}_t^*$ 232
11.1 Two-period consumption plans 253
12.1 A zero-coupon bond’s price, $p$, as a function of its yield, $y$ 289
13.1 Yield curves 308
13.2 Estimated yield curves 309
# List of figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3</td>
<td>Estimated real yield curves</td>
<td>312</td>
</tr>
<tr>
<td>14.1</td>
<td>Pay-offs from long and short futures positions</td>
<td>345</td>
</tr>
<tr>
<td>15.1</td>
<td>The slope of the fitted line is an estimate of the pure hedge ratio, $h^*$</td>
<td>376</td>
</tr>
<tr>
<td>18.1</td>
<td>Pay-offs at exercise for call and put options: long positions</td>
<td>443</td>
</tr>
<tr>
<td>18.2</td>
<td>Pay-offs at exercise for call and put options: short positions</td>
<td>444</td>
</tr>
<tr>
<td>18.3</td>
<td>Absence of arbitrage opportunities (AoAO) regions for European options</td>
<td>452</td>
</tr>
<tr>
<td>18.4</td>
<td>Bounds for American and European put option prices</td>
<td>456</td>
</tr>
<tr>
<td>19.1</td>
<td>Call and put option prices as a function of the asset price, $S$</td>
<td>470</td>
</tr>
<tr>
<td>19.2</td>
<td>The pattern of underlying asset prices: the two-period case</td>
<td>477</td>
</tr>
<tr>
<td>19.3</td>
<td>Sample paths for asset prices in continuous time</td>
<td>479</td>
</tr>
<tr>
<td>20.1</td>
<td>Interest rate caps and floors</td>
<td>501</td>
</tr>
<tr>
<td>20.2</td>
<td>Portfolio insurance with a put option</td>
<td>509</td>
</tr>
<tr>
<td>20.3</td>
<td>A long straddle</td>
<td>514</td>
</tr>
</tbody>
</table>
Preface

How can yet another book on finance be justified? The field is already well served with advanced works, many of impressive technical erudition. And, towards the other end of the academic spectrum, an abundance of mammoth texts saturates the MBA market. For the general reader, manuals confidently promising investment success compete with sensational diagnoses of financial upheavals to attract attention from the gullible, avaricious or unwary.

Alas, no one can expect to make a fortune as a consequence of reading this book. It has a more modest objective, namely to explore the economics of financial markets, at an ‘intermediate’ level – roughly that appropriate for advanced undergraduates. It is a work of exposition, not of original research. It unashamedly follows Keynes’s immortal characterization of economic theory as ‘an apparatus of the mind, a technique of thinking’. Principles – rather than assertions of doctrine, policy pronouncements or institutional description – are the focus of attention. If the following chapters reveal no get-rich-quick recipes, they should at least demonstrate why all such nostrums merit unequivocal disbelief.

This book evolved, over more years than the author cares to admit, from lecture notes for a course in financial economics taught at the University of Essex. For reasons of space, one topic – corporate finance – has been omitted from the book, though its core insight – the Modigliani–Miller theorem – is slipped in under options (chapter 18, section 6). While the chapters are intended to follow a logical sequence, pedagogy may require a different order. Any such tensions should be straightforward to resolve. For example, chapter 2 (market microstructure) appears early but was covered later in the course. Other changes of the order in which the chapters are studied should be easy to implement. Several obvious groupings are, however, readily apparent: portfolio selection in chapters 4 and 5; asset pricing in 6 to 9; bond markets in 12 and 13; futures in 14 to 16; and options in 18 to 20.
Preface

Taxing though it may be, chapter 7, on arbitrage, is so fundamental that it deserves study as early as possible. The overused and commonly abused notion of ‘efficiency’ infects much of finance: here it is confronted in chapter 3, though its presence cannot escape notice elsewhere (especially in chapters 10 and 11). ‘Behavioural finance’ perhaps warrants greater attention than it gets. Rather than segregate the topic into a ghetto of its own, an attempt is made to disperse its message across chapters of particular relevance (especially 3, 4 and 10). No apology is offered for adhering to a conventional treatment of financial markets, eschewing as far as possible the caprice of academic fashion.

Students enrolled for the lecture course were absolved responsibility for the technical appendices, included to justify and amplify claims in the text. The appendices were much the most satisfying sections to write and, it is hoped, will interest at least those readers embarking on graduate study. Lest there be misconception that the coverage of any topic is definitive, each chapter includes brief suggestions for further reading. A student’s work is never done.

The undergraduates to whom the lectures were addressed had a background in economics but most had not previously encountered the subject of finance. Consequently, while the book should be accessible to any moderately well-educated undergraduate, an acquaintance with microeconomics and quantitative methods is desirable. No more than the rudiments of differential calculus and probability theory, together with a smattering of statistics, are really necessary.

Successive generations of Essex students have contributed more to the final product than they can possibly have realized. Their toleration resembles that of opera audiences, which, in repeatedly shouting for an encore, imagine that the singer will eventually get it right. Individuals – too many to identify by name – have pointed out errors, queried obscurities and, most importantly, asked critical questions that revealed shortcomings. Attempts have been made to remedy the most glaring faults. Others undoubtedly lurk, as yet undiscovered.

A Website has been established at www.cambridge.org/0521612802. It is intended that this will form a repository for updates, feedback, exercises used in the lecture course and other supporting ancillary material. Given the unpredictable appearance, disappearance and revision of Web URLs, with a few exceptions these have been omitted from the text. The book’s Website should – notwithstanding the vicissitudes of the Web – enable rapid access to relevant locations via the links listed there.

The author’s procrastination in completing the manuscript would have exhausted the patience of a saint. But not of Patrick McCartan and Chris Harrison, at Cambridge University Press, the forbearance of whom has been remarkable. Persistent encouragement from Marcus Chambers and Abhinay Muthoo nuded the project back to life on countless occasions when the author would have
cheerfully abandoned it. Without their unwavering support, the entire enterprise would surely have been aborted. They must, therefore, be rendered partially culpable for the appearance of the book, though they are innocent of its remaining blemishes, infelicities and errors. For these, the author accepts exclusive responsibility.

R. E. Bailey
Wivenhoe Park
November 2004