

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/23775223>

The Econometrics of Financial Market

Article in *Macroeconomic Dynamics* · February 1998

DOI: 10.1017/S1365100598009092 · Source: RePEc

CITATIONS

2,453

READS

41,437

4 authors, including:



Andrew W Lo

Massachusetts Institute of Technology

426 PUBLICATIONS **52,457 CITATIONS**

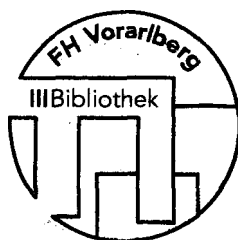
[SEE PROFILE](#)

The Econometrics of Financial Markets

John Y. Campbell

Andrew W. Lo

A. Craig MacKinlay



Princeton University Press
Princeton, New Jersey

Contents

List of Figures	xiii
List of Tables	xv
Preface	xvii
1 Introduction	3
1.1 Organization of the Book	4
1.2 Useful Background	6
1.2.1 Mathematics Background	6
1.2.2 Probability and Statistics Background	6
1.2.3 Finance Theory Background	7
1.3 Notation	8
1.4 Prices, Returns, and Compounding	9
1.4.1 Definitions and Conventions	9
1.4.2 The Marginal, Conditional, and Joint Distribution of Returns	13
1.5 Market Efficiency	20
1.5.1 Efficient Markets and the Law of Iterated Expectations	22
1.5.2 Is Market Efficiency Testable?	24
2 The Predictability of Asset Returns	27
2.1 The Random Walk Hypotheses	28
2.1.1 The Random Walk 1: IID Increments	31
2.1.2 The Random Walk 2: Independent Increments	32
2.1.3 The Random Walk 3: Uncorrelated Increments	33
2.2 Tests of Random Walk 1: IID Increments	33
2.2.1 Traditional Statistical Tests	33
2.2.2 Sequences and Reversals, and Runs	34

2.3	Tests of Random Walk 2: Independent Increments	41
2.3.1	Filter Rules.	42
2.3.2	Technical Analysis.	43
2.4	Tests of Random Walk 3: Uncorrelated Increments	44
2.4.1	Autocorrelation Coefficients.	44
2.4.2	Portmanteau Statistics.	47
2.4.3	Variance Ratios.	48
2.5	Long-Horizon Returns.	55
2.5.1	Problems with Long-Horizon Inferences.	57
2.6	Tests For Long-Range Dependence.	59
2.6.1	Examples of Long-Range Dependence.	59
2.6.2	The Hurst-Mandelbrot Rescaled Range Statistic	62
2.7	Unit Root Tests.	64
2.8	Recent Empirical Evidence.	65
2.8.1	Autocorrelations.	66
2.8.2	Variance Ratios.	68
2.8.3	Cross-Autocorrelations and Lead-Lag Relations	74
2.8.4	Tests Using Long-Horizon Returns.	78
2.9	Conclusion.	80
3	Market Microstructure	83
3.1	Nonsynchronous Trading.	84
3.1.1	A Model of Nonsynchronous Trading	85
3.1.2	Extensions and Generalizations	98
3.2	The Bid-Ask Spread.	99
3.2.1	Bid-Ask Bounce.	101
3.2.2	Components of the Bid-Ask Spread.	103
3.3	Modeling Transactions Data	107
3.3.1	Motivation	108
3.3.2	Rounding and Barrier Models.	114
3.3.3	The Ordered Probit Model	122
3.4	Recent Empirical Findings.	128
3.4.1	Nonsynchronous Trading.	128
3.4.2	Estimating the Effective Bid-Ask Spread.	134
3.4.3	Transactions Data	136
3.5	Conclusion.	144
4	Event-Study Analysis	149
4.1	Outline of an Event Study	150
4.2	An Example of an Event Study.	152
4.3	Models for Measuring Normal Performance	153
4.3.1	Constant-Mean-Return Model	154
4.3.2	Market Model.	155

4.3.3	Other Statistical Models	155
4.3.4	Economic Models	156
•4.4	Measuring and Analyzing Abnormal Returns	157
4.4.1	Estimation of the Market Model	158
• 4.4.2	Statistical Properties of Abnormal Returns	159
4.4.3	Aggregation of Abnormal Returns	160
4.4.4	Sensitivity to Normal Return Model	162
4.4.5	CARs for the Earnings-Announcement Example	163
4.4.6	Inferences with Clustering	166
4.5	Modifying the Null Hypothesis	167
4.6	Analysis of Power	168
4.7	Nonparametric Tests	172
4.8	Cross-Sectional Models	173
4.9	Further Issues	175
4.9.1,	Role of the Sampling Interval	175
4.9.2	Inferences with Event-Date Uncertainty	176
4.9.3	Possible Biases	177
4.10	Conclusion	178
5	The Capital Asset Pricing Model	181
5.1	Review of the CAPM	181
5.2	Results from Efficient-Set Mathematics	184
5.3	Statistical Framework for Estimation and Testing	188
5.3.1	Sharpe-Lintner Version	189
5.3.2	Black Version	196
5.4	Size of Tests	203
5.5	Power of Tests	204
5.6	Nonnormal and Non-IID Returns	208
5.7	Implementation of Tests	211
5.7.1	Summary of Empirical Evidence	211
5.7.2	Illustrative Implementation	212
5.7.3	Unobservability of the Market Portfolio	213
5.8	Cross-Sectional Regressions	215
5.9	Conclusion	217
6	Multifactor Pricing Models	219
6.1	Theoretical Background	219
6.2	Estimation and Testing	222
6.2.1	Portfolios as Factors with a Riskfree Asset	223
i 6.2.2	Portfolios as Factors without a Riskfree Asset	224
• 6.2.3	Macroeconomic Variables as Factors	226
6.2.4	Factor Portfolios Spanning the Mean-Variance Frontier	228

6.3	Estimation of Risk Premia and Expected Returns.	231
6.4	Selection of Factors.	233
6.4.1	Statistical Approaches.	233
6.4.2	Number of Factors.	238
6.4.3	Theoretical Approaches.	239
6.5	Empirical Results.	240
6.6	Interpreting Deviations from Exact Factor Pricing.	242
6.6.1	Exact Factor Pricing Models, Mean-Variance Analysis, and the Optimal Orthogonal Portfolio.	243
6.6.2	Squared Sharpe Ratios.	245
6.6.3	Implications for Separating Alternative Theories.	246
6.7	Conclusion.	251
7	Present-Value Relations	253
7.1	The Relation between Prices, Dividends, and Returns.	254
7.1.1	The Linear Present-Value Relation with Constant Expected Returns.	255
7.1.2	Rational Bubbles.	258
7.1.3	An Approximate Present-Value Relation with Time-Varying Expected Returns.	260
7.1.4	Prices and Returns in a Simple Example.	264
7.2	Present-Value Relations and US Stock Price Behavior.	267
7.2.1	Long-Horizon Regressions.	267
7.2.2	Volatility Tests.	275
7.2.3	Vector Autoregressive Methods.	279
7.3	Conclusion.	286
8	Intertemporal Equilibrium Models	291
8.1	The Stochastic Discount Factor.	293
8.1.1	Volatility Bounds.	296
8.2	Consumption-Based Asset Pricing with Power Utility.	304
8.2.1	Power Utility in a Lognormal Model.	306
8.2.2	Power Utility and Generalized Method of Moments.	314
8.3	Market Frictions.	314
8.3.1	Market Frictions and Hansen-Jagannathan Bounds.	315
8.3.2	Market Frictions and Aggregate Consumption Data.	316
8.4	More General Utility Functions.	326
8.4.1	Habit Formation.	326
8.4.2	Psychological Models of Preferences.	332
8.5	Conclusion.	334

9	Derivative Pricing Models	339
9.1	Brownian Motion	341
9.1.1	Constructing Brownian Motion	341
9.1.2	Stochastic Differential Equations	346
9.2	A Brief Review of Derivative Pricing Methods	349
9.2.1	The Black-Scholes and Merton Approach	350
9.2.2	The Martingale Approach	354
9.3	Implementing Parametric Option Pricing Models	355
9.3.1	Parameter Estimation of Asset Price Dynamics	356
9.3.2	Estimating a in the Black-Scholes Model	361
9.3.3	Quantifying the Precision of Option Price Estimators	367
9.3.4	The Effects of Asset Return Predictability	369
9.3.5	Implied Volatility Estimators	377
9.3.6	Stochastic Volatility Models	379
9.4	Pricing Path-Dependent Derivatives Via Monte Carlo Simulation	382
9.4.1	Discrete Versus Continuous Time	383
9.4.2	How Many Simulations to Perform	384
9.4.3	Comparisons with a Closed-Form Solution	384
9.4.4	Computational Efficiency	386
9.4.5	Extensions and Limitations	390
9.5	Conclusion	391
10	Fixed-Income Securities	395
10.1	Basic Concepts	396
10.1.1	Discount Bonds	397
10.1.2	Coupon Bonds	401
10.1.3	Estimating the Zero-Coupon Term Structure	409
10.2	Interpreting the Term Structure of Interest Rates	413
10.2.1	The Expectations Hypothesis	413
10.2.2	Yield Spreads and Interest Rate Forecasts	418
10.3	Conclusion	423
11	Term-Structure Models	427
11.1	Affine-Yield Models	428
11.1.1	A Homoskedastic Single-Factor Model	429
11.1.2	A Square-Root Single-Factor Model	435
11.1.3	A Two-Factor Model	438
11.1.4	Beyond Affine-Yield Models	441
11.2	Fitting Term-Structure Models to the Data	442
11.2.1	Real Bonds, Nominal Bonds, and Inflation	442
11.2.2	Empirical Evidence on Affine-Yield Models	445

11.3	Pricing Fixed-Income Derivative Securities	455
11.3.1	Fitting the Current Term Structure Exactly.	456
11.3.2	Forwards and Futures.	458
11.3.3	Option Pricing in a Term-Structure Model.	461
11.4	Conclusion.	464
12	Nonlinearities in Financial Data ,	467
12.1	Nonlinear Structure in Univariate Time Series.	468
12.1.1	Some Parametric Models.	470
12.1.2	Univariate Tests for Nonlinear Structure.	475
12.2	Models of Changing Volatility.	479
12.2.1	Univariate Models.	481
12.2.2	Multivariate Models.	490
12.2.3	Links between First and Second Moments.	494
12.3	Nonparametric Estimation.	498
12.3.1	Kernel Regression.	500
12.3.2	Optimal Bandwidth Selection.	502
12.3.3	Average Derivative Estimators.	504
12.3.4	Application: Estimating State-Price Densities	507
12.4	Artificial Neural Networks	512
12.4.1	Multilayer Perceptrons.	512
12.4.2	Radial Basis Functions.	516
12.4.3	Projection Pursuit Regression.	518
12.4.4	Limitations of Learning Networks.	518
12.4.5	Application: Learning the Black-Scholes Formula	519
12.5	Overfitting and Data-Snooping.	523
12.6	Conclusion.	524
	Appendix	527
A.1	Linear Instrumental Variables.	527
A.2	Generalized Method Of Moments	532
A.3	Serially Correlated and Heteroskedastic Errors.	534
A.4	GMM and Maximum Likelihood	536
	References	541
	Author Index	587
	Subject Index	597