
Contents

Preface	XV
Audience and style	XVII
Structure of the work	XVIII
A guided tour by means of a simplistic example	XIX
Acknowledgments	XXVI

Part I The statistics of asset allocation

1	Univariate statistics	3
1.1	Building blocks.....	3
1.2	Summary statistics	9
1.2.1	Location	9
1.2.2	Dispersion	11
1.2.3	Higher-order statistics	14
1.2.4	Graphical representations	15
1.3	Taxonomy of distributions	16
1.3.1	Uniform distribution	16
1.3.2	Normal distribution	18
1.3.3	Cauchy distribution	20
1.3.4	Student t distribution	22
1.3.5	Lognormal distribution	24
1.3.6	Gamma distribution	26
1.3.7	Empirical distribution.....	28
1.T	Technical appendix	www
1.E	Exercises	www
2	Multivariate statistics	33
2.1	Building blocks.....	34
2.2	Factorization of a distribution	38
2.2.1	Marginal distribution	38
2.2.2	Copulas	40

2.3	Dependence	45
2.4	Shape summary statistics	48
2.4.1	Location	48
2.4.2	Dispersion	50
2.4.3	Location-dispersion ellipsoid	54
2.4.4	Higher-order statistics	57
2.5	Dependence summary statistics	59
2.5.1	Measures of dependence	59
2.5.2	Measures of concordance	64
2.5.3	Correlation	67
2.6	Taxonomy of distributions	70
2.6.1	Uniform distribution	70
2.6.2	Normal distribution	72
2.6.3	Student t distribution	77
2.6.4	Cauchy distribution	81
2.6.5	Log-distributions	82
2.6.6	Wishart distribution	84
2.6.7	Empirical distribution	87
2.6.8	Order statistics	89
2.7	Special classes of distributions	91
2.7.1	Elliptical distributions	91
2.7.2	Stable distributions	96
2.7.3	Infinitely divisible distributions	98
2.T	Technical appendix	www
2.E	Exercises	www
3	Modeling the market	101
3.1	The quest for invariance	103
3.1.1	Equities, commodities, exchange rates	105
3.1.2	Fixed-income market	109
3.1.3	Derivatives	114
3.2	Projection of the invariants to the investment horizon	122
3.3	From invariants to market prices	126
3.3.1	Raw securities	126
3.3.2	Derivatives	129
3.4	Dimension reduction	131
3.4.1	Explicit factors	133
3.4.2	Hidden factors	138
3.4.3	Explicit vs. hidden factors	143
3.4.4	Notable examples	145
3.4.5	A useful routine	147
3.5	Case study: modeling the swap market	150
3.5.1	The market invariants	150
3.5.2	Dimension reduction	151
3.5.3	The invariants at the investment horizon	160
3.5.4	From invariants to prices	162

3.T	Technical appendix	www
3.E	Exercises	www

Part II Classical asset allocation

4	Estimating the distribution of the market invariants	169
4.1	Estimators	171
4.1.1	Definition	172
4.1.2	Evaluation	173
4.2	Nonparametric estimators	178
4.2.1	Location, dispersion and hidden factors	181
4.2.2	Explicit factors	184
4.2.3	Kernel estimators	185
4.3	Maximum likelihood estimators	186
4.3.1	Location, dispersion and hidden factors	190
4.3.2	Explicit factors	192
4.3.3	The normal case	193
4.4	Shrinkage estimators	200
4.4.1	Location	201
4.4.2	Dispersion and hidden factors	204
4.4.3	Explicit factors	209
4.5	Robustness	209
4.5.1	Measures of robustness	211
4.5.2	Robustness of previously introduced estimators	216
4.5.3	Robust estimators	221
4.6	Practical tips	223
4.6.1	Detection of outliers	223
4.6.2	Missing data	229
4.6.3	Weighted estimates	232
4.6.4	Overlapping data	234
4.6.5	Zero-mean invariants	234
4.6.6	Model-implied estimation	235
4.T	Technical appendix	www
4.E	Exercises	www
5	Evaluating allocations	237
5.1	Investor's objectives	239
5.2	Stochastic dominance	243
5.3	Satisfaction	249
5.4	Certainty-equivalent (expected utility)	260
5.4.1	Properties	262
5.4.2	Building utility functions	270
5.4.3	Explicit dependence on allocation	274
5.4.4	Sensitivity analysis	276
5.5	Quantile (value at risk)	277
5.5.1	Properties	278

5.5.2	Explicit dependence on allocation	282
5.5.3	Sensitivity analysis	285
5.6	Coherent indices (expected shortfall)	287
5.6.1	Properties	288
5.6.2	Building coherent indices	292
5.6.3	Explicit dependence on allocation	296
5.6.4	Sensitivity analysis	298
5.T	Technical appendix	www
5.E	Exercises	www
6	Optimizing allocations	301
6.1	The general approach	302
6.1.1	Collecting information on the investor	303
6.1.2	Collecting information on the market	305
6.1.3	Computing the optimal allocation	306
6.2	Constrained optimization	311
6.2.1	Positive orthants: linear programming	313
6.2.2	Ice-cream cones: second-order cone programming	313
6.2.3	Semidefinite cones: semidefinite programming	315
6.3	The mean-variance approach	315
6.3.1	The geometry of allocation optimization	316
6.3.2	Dimension reduction: the mean-variance framework	319
6.3.3	Setting up the mean-variance optimization	320
6.3.4	Mean-variance in terms of returns	323
6.4	Analytical solutions of the mean-variance problem	326
6.4.1	Efficient frontier with affine constraints	327
6.4.2	Efficient frontier with linear constraints	330
6.4.3	Effects of correlations and other parameters	332
6.4.4	Effects of the market dimension	335
6.5	Pitfalls of the mean-variance framework	336
6.5.1	MV as an approximation	336
6.5.2	MV as an index of satisfaction	338
6.5.3	Quadratic programming and dual formulation	340
6.5.4	MV on returns: estimation versus optimization	342
6.5.5	MV on returns: investment at different horizons	343
6.6	Total-return versus benchmark allocation	347
6.7	Case study: allocation in stocks	354
6.7.1	Collecting information on the investor	355
6.7.2	Collecting information on the market	355
6.7.3	Computing the optimal allocation	357
6.T	Technical appendix	www
6.E	Exercises	www

Part III Accounting for estimation risk

7	Estimating the distribution of the market invariants	363
7.1	Bayesian estimation	364
7.1.1	Bayesian posterior distribution	364
7.1.2	Summarizing the posterior distribution	366
7.1.3	Computing the posterior distribution	369
7.2	Location and dispersion parameters	370
7.2.1	Computing the posterior distribution	370
7.2.2	Summarizing the posterior distribution	373
7.3	Explicit factors	377
7.3.1	Computing the posterior distribution	377
7.3.2	Summarizing the posterior distribution	380
7.4	Determining the prior	383
7.4.1	Allocation-implied parameters	385
7.4.2	Likelihood maximization	387
7.T	Technical appendix	www
7.E	Exercises	www
8	Evaluating allocations	389
8.1	Allocations as decisions	390
8.1.1	Opportunity cost of a sub-optimal allocation	390
8.1.2	Opportunity cost as function of the market parameters	394
8.1.3	Opportunity cost as loss of an estimator	397
8.1.4	Evaluation of a generic allocation decision	401
8.2	Prior allocation	403
8.2.1	Definition	403
8.2.2	Evaluation	404
8.2.3	Discussion	406
8.3	Sample-based allocation	407
8.3.1	Definition	407
8.3.2	Evaluation	408
8.3.3	Discussion	412
8.T	Technical appendix	www
8.E	Exercises	www
9	Optimizing allocations	417
9.1	Bayesian allocation	418
9.1.1	Utility maximization	419
9.1.2	Classical-equivalent maximization	421
9.1.3	Evaluation	422
9.1.4	Discussion	425
9.2	Black-Litterman allocation	426
9.2.1	General definition	426
9.2.2	Practicable definition: linear expertise on normal markets	429
9.2.3	Evaluation	433
9.2.4	Discussion	436

9.3	Resampled allocation	437
9.3.1	Practicable definition: the mean-variance setting	438
9.3.2	General definition	440
9.3.3	Evaluation	443
9.3.4	Discussion	445
9.4	Robust allocation	445
9.4.1	General definition	445
9.4.2	Practicable definition: the mean-variance setting	450
9.4.3	Discussion	453
9.5	Robust Bayesian allocation	454
9.5.1	General definition	455
9.5.2	Practicable definition: the mean-variance setting	457
9.5.3	Discussion	459
9.T	Technical appendix	www
9.E	Exercises	www

Part IV Appendices

A	Linear algebra	465
A.1	Vector space	465
A.2	Basis	468
A.3	Linear transformations	469
A.3.1	Matrix representation	470
A.3.2	Rotations	471
A.4	Invariants	472
A.4.1	Determinant	472
A.4.2	Trace	474
A.4.3	Eigenvalues	474
A.5	Spectral theorem	475
A.5.1	Analytical result	475
A.5.2	Geometrical interpretation	478
A.6	Matrix operations	480
A.6.1	Useful identities	480
A.6.2	Tensors and Kronecker product	482
A.6.3	The "vec" and "vech" operators	483
A.6.4	Matrix calculus	485
B	Functional Analysis	487
B.1	Vector space	487
B.2	Basis	490
B.3	Linear operators	493
B.3.1	Kernel representations	494
B.3.2	Unitary operators	494
B.4	Regularization	496
B.5	Expectation operator	499
B.6	Some special functions	501

References	505
List of figures	515
Notation	519
Index	525



<http://www.springer.com/978-3-642-00964-8>

Risk and Asset Allocation

Meucci, A.

2005, XXVI, 532 p., Softcover

ISBN: 978-3-642-00964-8