Index

References to figures are given in **bold** type. References to tables are given in *italic* type.

ACF see autocorrelation functions
adaptive lasso, 48, 50, 51
anti-monotone sets, 208
AR(1) process
Eigen subspace, 70, 91–2
KLT kernel derivation, 79–82
orthogonal subspace, 69–71
Karhunen-Loeve transform, 70–1
performance matrices, 71
power spectral density, 78
stochastic signal model, 68
arbitrage, 3
ARCH model, 141
nonparametric tests, 173–4
parametric tests, 172–3
Archimedean copula, 181, 182
assets, mean-reverting, 23–4
autocorrelation functions (ACF), 164–5
Kendall’s tau, 166–7, 169
misspecification testing
conditional heteroscedasticity, 171–2
Ljung-Box, 171
Spearman’s rho, 168–9, 169–71
autocovariance, 164
autoregressive conditional heteroscedasticity (ARCH), 141
backward simulation (BS), 222–7
BEKK Garch model, 175
bias, 267
BIC criterion, 175
bid-ask price, 4
big data finance, 2
Black-Scholes model, 136–7, 203
BS method, 203
capital market line, 12
causal strength modeling, 42
causal strength modeling (CSM), 51–2
CDVine, 185
CLIME, 110, 111
cointegration-based trading strategies, 23
collateralized debt obligation (CDO), 279
conditional sparsity, 102
conditional value at risk (CVaR), 233, 234–42
minimization, 240–2, 263
support vector machines, 247–52

© 2016 John Wiley & Sons, Ltd. Published 2016 by John Wiley & Sons, Ltd.
conditional value at risk (CVaR) (continued)
portfolio selection, 241–2
as risk measure, 263
robust optimization, 259–61
under finite scenarios, 236–8
under normal distribution, 235
constant relative risk aversion (CRRA), 159
constant shift insensitivity, 269
contract asymptotics, 141–2
convex relaxation, 16
copula modeling, 1, 179–85
Archimedean, 181, 182
multiple variables, 183–5
parametric, 181–3
product copula, 181
software, 185
copula (software), 185
correlation measures, 164–5
copulas, 179–85
fitting, 180–1
dependence types, 185–6
positive and negative, 185–6
tail, 187–8
Granger causality, 176–8
Huber-type, 166
Kendall’s tau, 166–7
misspecification testing
ARCH effects, 172–4
Ljung-Box, 171
multivariate, 176
multiple variables, 183–5
Spearman’s rho, 168–9, 179, 182
covariance matrix estimation, 100–2
factor analysis, 100–8
asymptotic results, 105–7
example, 107–8
threshold, 105
unknown factors, 104–5
pure factor models, 126–7
optimal weight matrix, 129–30
covariance selection, 109
credit default swaps, 279
CRSP database, 124–6
CVar see conditional value at risk

Dantzig selector, 111
dependence, 185–7
deviation, 270
Dirichlet distribution, 58
discrete cosine transform (DCT), 67, 71, 72
discrete Fourier transform (DFT), 67
domain description, 245–6
dynamic programming equation, 155–6
efficient frontier, 12
efficient market hypothesis (EMH), 3
Eigen decomposition see principal components analysis
EJD algorithm, 215, 219–20
error decomposition, 274
error measures, 269
error projection, 269
essential infimum, 268
essential supremum, 268
estimator’s breakdown point, 284–5
ETF see exchange-traded funds
Ev-SVC, 248–9
exchange-traded funds, 42
expectation-maximization, 57
expected shortfall, 263
extreme joint distribution (EJD) algorithm, 215, 219–20
factor analysis, 100, 100–8, 120
covariance matrix estimation
asymptotic results, 105–6
threshold, 105
unknown factors, 104
factor-pricing model, 121–2
fallout, 286
Fama-French model, 107–8
fixed income instruments, 9
fixed strike price, 136
fixed transforms, 67
Frank copula, 182
Frechet-Hoeffding theorem, 215–17
Fused-DBN, 62, 63
GARCH model, 141, 172–4
BEKK GARCH model, 175
VECH GARCH, 175
Gauss-Markov theorem, 268
Gaussian copula, 181
genomic networks, 118–19
GICS, 115–16
Global Financial Crisis, 43
Global Industry Classification Standard (GICS), 115–16
global minimum variance portfolio, 120–1
Granger causality, 46–7, 176–7
nonlinear, 177–9
graphical Dantzig selector, 110
Green’s function, 143
group lasso, 20, 47
group OMP, 49, 51–2
H-J test, 178
high-density region estimation, 245–6
high-frequency trading, 9
hinge loss, 244
Huber-type correlations, 166
implied volatility asymptotics, 143–5
implied volatility skew, 136
index tracking, 19
inference function for margins (IFM) method, 180
intensity randomization, 196–7
intercept, 267
interior point (IP), 53
interior point (IP method), 53
inverse projection, 270
investment risk, 2
iShares, 53–5

Japan, 43, 55
jump-diffusion processes, 191–2
Karhunen-Loève transform (KLT), 67–8
kernel derivation, 72–9
continuous process with exponential autocorrelation, 74–6
eigenanalysis of discrete AR(1) process, 76–7
fast derivation, 79–82
NASDAQ-100 index, 93–7
subspace sparsity, 82–4
pdf-optimized midtread reader, 84–6
see also principal components analysis
Karhunen-Loève expansion, 76
Kendall’s tau, 166–7, 169, 179, 182
kernel trick, 242
Kolmogorov backward equation (KBE), 172
Landweber’s iteration, 15
lasso regression, 17, 46, 252
adaptive, 47, 48, 50, 51
group, 47, 48, 57
SQRT, 112–13
least absolute deviation (LAD), 53
least median of squares (LMS) regression, 285
least-squares methods, 14, 268
ordinary least squares, 103, 251
POET and, 104
regularized, 48
temporal causal modeling, 48
least-trimmed-squares (LTS) regression, 285
leverage effect, 140
Lévy kernel, 150–1
linear regression, 283–4
liquidity, 4
Ljung-Box test, 171
local volatility models, 139
local-stochastic volatility (LSV) models, 140–1, 146–8, 155–7
Heston, 148–50, 149
Lévy-type, 150–2
market incompleteness, 139
market microstructure, 4–5
market price of risk, 153
market risk see investment risk
Markov-switched TCM, 60–4
Markowitz bullet, 12
Markowitz portfolio selection, 1, 3
elastic net strategy, 19
as inverse problem, 13–15
portfolio description, 11–13
as regression problem, 13
sparse, 15–17
Markowitz portfolio selection (continued)
empirical validation, 17–18
optimal forecast combination, 20–1
portfolio rebalancing, 18
portfolio replication, 19
see also sparse Markowitz portfolios
matrix deflation, 30
maximum a posteriori (MAP) modeling, 56, 58–9
mean-absolute deviation, 277–8, 279
mean-reverting portfolios, 24, 29
crossing statistics, 28, 31
mean-reversion proxies, 25–6
numerical experiments, 32–9
basket estimators, 33
historical data, 32–3
Jurek and Yang strategy, 33, 36, 37
Sharpe ratio robustness, 36–7
tradeoffs, 38–9, 38
transaction costs, 33–4
optimal baskets, 28–9
portmanteau criterion, 27–8, 29, 31
predictability
multivariate case, 26–7
univariate case, 26
semidefinite relaxations, 30–1
portmanteau, 31
predictability, 30–1
volatility and sparsity, 24–5
mean-variance efficiency, 122
Merton problem, 155–60
mevalonate (MVA) pathway, 118
misspecification testing
ARCH/GARCH, 172–4
Ljung-Box test, 171
multivariate, 176
model asymptotics, 142
monotone distributions, 208–14, 238–9
mortgage pipeline risk, 286
MSCI Japan Index, 42
NASDAQ-100, 93–7
negative dependence, 185–6
news analysis, 9
Newton method, 53
no-arbitrage pricing, 139
no-short portfolios, 16–17
nonnegative space PCA, 83
nonnegative sparse PCA, 83
optimal order execution, 9
optimized certainty equivalent (OCE), 264
option pricing
asymptotic expansions, 141–2
contract, 142
implied volatility, 143–5
model, 142–3
model coefficient expansions, 146–50
model tractability, 145–6
Oracle property, 48
ordinary least square (OLS), 103, 251
Ornstein–Uhlenbeck (OU) process, 68
orthogonal patching pursuit (OMP), 49, 51–2, 54
outlier detection, 245–6
panel data models, 127–9
partial integro-differential equation (PIDE), 141
Pearson correlation coefficient, 162
penalized matrix decomposition, 83
penalties relative to expectation, 269
pension funds, 9
perturbation theory, 142–3
POET, 104, 120–1
Poisson processes, 193–6
backward simulation (BS), 222–7
common shock model, 196
extreme joint distributions, 207–19
approximation, 217–19
Frechet-Hoeffding theorem, 215–17
monotone, 208–14
optimization problem, 207–8
intensity randomization, 196–7
numerical results, 219–22
simulation
backward, 200–6
forward, 197–9
model calibration, 206
Poisson random vectors, 205
Poisson-Wiener process, 222–7
portfolio manager, 2
portfolio optimization, 3
1=N puzzle, 13
Markowitz, 11–12
portfolio rebalancing, 18–19
portfolio risk estimation, 119–21
positive dependence, 185–6
positive homogeneity, 239
power enhancement test, 123–4
precision matrix estimation, 109–10
applications, 115–17
column-wise, 110–11
portfolio risk assessment, 119–26
TIGER, 112–14
application, 115–17
computation, 114
genomic network application, 118–19
theoretical properties, 114–15
tuning-insensitive procedures, 111–12
price inefficiency, 3
principal components analysis (PCA), 34
principal orthogonal complement, 104
principal orthogonal complement
thresholding (POET) estimator, 104
principal components analysis (PCA),
36–7, 67, 126
discrete autoregressive (AR(1)) model,
68–70
fast kernel derivation, 79–82
Eigen subspace, 70–1, 91–2
Eigen subspace sparsity, 82–3
KLT kernel
continuous process with exponential
autocorrelation, 74
eigenanalysis of a discrete AR(1)
process, 76–9
orthogonal subspace, 69–72
Eigen subspace, 70–2
performance metrics, 71
pure factor models, 126–7
sparse methods, 83–4
AR(1), 89–91
Eigen subspace quantization, 86
Eigenvector pdf, 87–9
pdf-optimized midtread quantizer,
84–6
performance, 91–3
pulse code modulation (PCM), 71
pure factor model, 130
Q-TCM, 52
quadratic penalty, 14
quantile regression, 251
quantile TCM, 52–5, 54–5
quasi–Monte Carlo (QMC) algorithms, 203
reduced convex hulls, 257, 258
regressant, 267
regression analysis, 267–8
CVar-based, 251–3
error decomposition, 273–4
error and deviation measures, 268–71
lasso see lasso regression
least-squares, regularized, 48
least-squares methods, 275–7
linear regression, 283–4
median regression, 277–81
ordinary least squares, 251
quantile regression, 281–3
risk envelopes and identifiers, 271–3
robust, 284–6
support vector regression, 246–7
regressors, 267
return on investment (ROI), 2–3
ridge regression, 251
risk acceptable linear regression, 284
risk envelopes, 271–3
risk inference, 121
risk preferences, 268
risk quadrangle, 264
risk-neutrality, 139
risk-normalized return, 2–3
robust optimization, distributional, 259–61
robust regression, 284–6

SCoTLASS, 83
SDP see semidefinite programs
SDP relaxations for sparse PCA (DSPCA),
83
securities, 4, 11, 135
securities markets, 4
semidefinite programs, 30
relaxation tightness, 31–2
Sharpe ratio, 2–3, 36–7
transaction costs and, 38–9
Sherman–Morrison–Woodbury formula, 103
shift operator, 145
shortselling, 3
signal-to-quantization-noise ratio (SQNR), 85
Sklar’s theorem, 179–80
soft convex hulls, 257
soft thresholding, 84
sparse KLT, 89–91
sparse Markowitz portfolios, 15–17
empirical validation, 17–18
portfolio rebalancing, 18–19
sparse modeling, 5–6
sparse PCA via regularized SVD (sPCA–rSVD), 83
sparse vector autoregressive (VAR) models, 42
Spearman’s rho, 168–9, 169–70, 179, 182
SQR–lasso, 112–13
stationary sequences, 165
statistical approximation theory, 268
statistical arbitrage, 3
stochastic volatility, 1, 135
Black–Scholes model, 136–7
dynamic programmable equation, 155–7
implied volatility, 137
local volatility models, 139–40
Merton problem, 155–60
separation of timescales approach, 152–3
stochastic volatility models, 140
local (LSV), 140–1
with jumps, 141
volatility modeling, 137–41
volatility of volatility, 152
stock exchanges, 4
stock return analysis, 62–3, 64
Strong Law of Large Numbers, 192, 212
support vector machines (SVM), 233–4, 263
classification, 242–3
C-support, 243–4
duality, 256–9
soft-margin, 244–5
v-SVM, 247
geometric interpretation, 257–9
support vector regression (SVR), 246–7
Survey of Professional Forecasters (SPF), 21
Switzerland, 43
tail dependence, 187–8
tail VaR, 263
temporal causal modeling (TCM), 42, 44–5
algorithm overview, 47
Bayesian group lasso, 57–8
extensions
causal strength modeling, 51–2
quantile TCM, 52–5
Granger causality and, 46–7
grouped method, 47–9
greedy, 49
regularized least-squares, 48
Markov switching model, 56–7
stock return analysis, 62–3
synthetic experiments, 60–2
maximum a posteriori (MAP) modeling, 58–9
quantile TCM, 54–5
regime change identification, 55–63
algorithm, 58–60
synthetic experiments, 49–50, 60–2
data generation, 49–50, 60–1
TIGER, 112–14
computation, 114
Tikhonov regularization, 14
time series, 165
Tobin two-fund separation theorem, 12
transcendental equations, 73–4
transform coding, 71
translation invariance, 239
truncated singular value decomposition (TSVD), 15
tuning-insensitivity, 113
TV-DBN, 61, 62
two-tailed [alpha]-value-at-risk (VaR) deviation, 286
unbiased linear regression, 283–4
v-property, 253–5
\(\nu\)-SVM, 257–8
\(\nu\)-SVR, 247, 251–2
value function, 156
value-at-risk, 234
Vapnik–Chervonenkis theory, 243
VECH GARCH model, 175
vector autoregression (VAR), 25, 49–50, 61, 174
  multivariate volatility, 175–6
temporal causal modeling, 57–8, 61–2
VineCopula, 185
volatility, 38–9
volatility of volatility modeling, 152
Wald test, 122–3
weighted principal components (WPC), 127, 130–1
Yahoo! Finance, 115–17
zero crossing rate, 28