Index

1/f noise 50–2
spectral density 50, 59

algorithmic complexity theory 11
American option 114
American Stock Exchange (AMEX) 74
amount of information 12, 57
Anderson localization theory 103
anticorrelated velocity changes 91
arbitrage 8
opportunities 9, 104, 117–19, 124
pricing theory 103
ARCH processes 61, 76, 87
ARCH(1) process 77–80
ARCH(p) process 77, 80
asset-specific risk 103
attractors in probability space 21, 27, 62
autocorrelation function 44–50, 53–5, 57
autocovariance matrix 98, 103
central limit theorem (CLT) 14, 17–19, 21, 83
center of mass (CoM) 5
chaotic time evolution 5
characteristic function 23–6, 31–3
Chebyshev solution 20
clearing house 114
Coca Cola Co. stock 34, 54, 99–101, 106
contingent claim 5
continuous limit 15
correlation coefficient 98–102, 104, 105
correlation matrix 103
covariance 103, 128
deflated price changes 38
delivery date 113–14
delivery price 113
derivative 5, 113, 115
derivatives contracts 1, 5, 60
disordered systems 129
diffusive process 56, 60, 93
dimensional consistency 89, 94–6
discontinuous stock returns 60, 62, 122–3, 128
discounted price changes 38
disordered frustrated systems 6
dissipative range 92, 94
distance between stocks 105–6, 112
distributions of price changes 7
disorder 92, 94
disorder of time 4, 27
disorderly systems 92, 94
dissipative range 92, 94
Dow–Jones Industrial Average (DJIA) 11, 99, 100, 110–11
economic factors 98, 104
growth 36
information 12, 112
recession 36
efficient market 8–10, 13, 56, 67, 104
efficient portfolio 98
eigenvalues of a random matrix 103
eigenvector 103
Einstein 2–3
energy dissipation rate per unit mass 94–5
Euclidean distance 105–6
European option 114, 119, 121
exercise price 114
expiration date 114, 126
Exxon stock 40, 106
factor-risk premia 103
financial assets 127
contracts 113, 124
ideal market 121, 127
markets 8, 29, 58, 60, 88, 96, 98, 122–3
real market 122, 127
securities 113
fixed point 21
fluid velocity 90, 92
Forbes Annual Report on American Industry 112
foreign exchange market 36, 40–2, 57
forward contract 113–14, 116
forward price 113
fractional Brownian motion 96
functional space of pdfs 21, 27
future contract 113–14
GARCH processes 61
GARCH (1,1) process 81–7, 92
GARCH (p,q) process 80, 83
Gaussian attractor in probability 21, 28, 96
conditional pdf 80–1
granular matter 88
graph theory 107
gross domestic product 36–7
Hamiltonian 88
heat-transfer equation 120
hedger 115–16
hedging 116–17
perfect hedging of a portfolio 116, 127
high-frequency financial data 35, 38–9, 41, 53,
55–6, 59–60, 70–5, 85–7
indexed hierarchical tree 107–10
inertial range 89, 92, 94, 96
infinitely divisible 30–3
stochastic processes 31–2
TLF 67
infinitesimal random variables 30

Index
inflation 36
information 9, 12, 88
information theory 112
interest rate 122, 124
stochastic 127
intermittency 96
intermittent behavior 90
International Monetary Fund (IMF) 37
intraday fluctuations 41–2, 59
Ito's lemma 118–19
Ito's stochastic process 118
jump-diffusion 127
model 61, 123
Khintchine limit theorem 30, 33
Kolmogorov 11, 20
Kolmogorov's 2/3 law 95
Kolmogorov's theory 90, 97
Kruskal's algorithm 108
kurtosis 79, 81, 85
leptokurtic distribution 7, 60, 62–4, 68, 80, 86, 92
Levy flight 65
truncated (TLF) 61, 64–7, 92, 96
Levy stable attractors 28
distribution 4, 23, 25–7, 69
hypothesis 62
limit theorems 62
for infinite divisible distributions 30
for stable distributions 27–8
Lindegberg condition 17
long position 113
long-range correlated stochastic processes 44,
49–53, 55–7, 59
Majorana 6
market imperfections 122–3, 127
microstructure 123
markets 9, 57
efficient see efficient market
fractionless 123
idealized 113, 118, 127
Markov processes 51, 83
martingales 10–11, 136
maturity time 115, 124
maximum likelihood methods 57
metrology 36
minimal-spanning tree (MST) 107–12
mixture of Gaussian distributions 61, 63–4
modeling of friction 88
moments 14
finite 'unconditional' variance 78, 82
finite variance 60, 64, 68, 71, 75, 84
higher 60, 82
infinite 26, 62, 64
National Association of Securities Dealers
Automated Quotation (NASDAQ) 74
Navier–Stokes equations 89
New York Stock Exchange (NYSE) 35, 40, 61–2, 74, 99
non-Gaussian
scaling 62, 70–2
stable distribution see Lévy stable distribution
nonlinear dynamics 5
nonstationary stochastic process 50, 55, 90, 124
number of transactions 8, 39, 42, 63
one-period asset returns 103
option-pricing formula see Black and Scholes, option-pricing
formula problem 118, 120, 122, 129
options 114, 125
pairwise independence 53, 57, 59
of price changes 58
of random variables 30
Poisson process 31, 128
portfolio 99, 101
efficient 98
management 35
replicating 121, 123, 128
power spectrum 49, 57, 60
power-law
autocorrelation function 49, 57–8
distribution 2, 4, 26–9
price change distributions 7, 29–30, 33, 75, 122
price scales 36
probability density function (pdf)
asymptotic 59–60, 72–3, 76
Cauchy (or Lorentzian) 15, 17, 23, 25, 63
conditional Gaussian 78, 80, 87
double triangle 18
Gamma 32
Gaussian 15, 17, 21–3, 31, 60, 63–7, 69, 80
hyperbolic 61
Lévy stable 25, 69, 71
log normal 58
Student’s t-distribution 61–3
truncated Lévy flight (TLF) 61, 64–7, 72–3, 92
uniform 15, 19
probability of return to the origin 26, 65–7, 69–73, 85, 87, 93, 95
Procter & Gamble stock 99–101, 106
put option 114–15
random
matrix theory 103
variables 4, 14–24, 27–8, 31–3, 37, 45, 47–9, 57, 76–7, 80–3, 118
walk 2–3, 10, 14–15, 53, 55, 58, 70
rare events 74, 121
reference units 35
returns 38
Reynolds number 89–90, 92
riskless investment 38, 116, 119–20
portfolio 116, 121–3
risk-neutrality 121
scaling 6, 14, 19, 60, 64, 69, 71–2, 85–7, 93, 129
relations 27, 63–4, 71
self-organized systems 6
self-similarity 26, 62, 68, 71
short position 113
short-range correlated stochastic processes 44, 49, 53, 58
spectral density 53–6, 59, 91, 94
speculation 115–17
speed of convergence 19–20, 22
spinning glass 103, 107
St Petersburg paradox 28
stable distribution see probability density function, Gaussian; Lévy stable
stochastic process 4, 17, 25–6, 31–3, 62, 65, 71
Standard & Poor’s 500 index (S&P 500) 30, 35, 41, 53, 55–9, 68–72, 85, 87, 90, 99, 101–2, 112
stationary stochastic processes 44
asymptotic 45, 59–60, 76, 90
sub-order 45
strict-sense 45, 58
wide-sense 45
strange attractor 5
strike price 114, 116, 124, 126
subdominant ultrametric 107, 111–12
subordinated stochastic process 63
superdiffusive behavior 56, 93
synchronous pair of assets 98, 103–6
synthetic option 121
taxonomy 106–7, 112
Taylor hypothesis 90
Taylor microscale Reynolds number 92
technical analysis 7
time
index 42
to maturity 125
scales 36, 39
thermodynamics
equilibrium 123
non-equilibrium 123
topological space 106, 112
trading
activity 41
strategy 117, 121
time 39–41
volume 63
traffic flow 50
transaction costs 9, 118, 127
triangular inequality 106–7
turbulence 7, 88–97
fully developed 88–90, 92
ultrametric
distance 107
distance matrix 109
inequality 107
Index

spaces 106–7
universal 6, 129
velocity
  autocorrelation function 49
fluctuations of a turbulent fluid 90–3, 96
volatility 30, 41, 53, 57–9, 73–4, 76, 90, 94, 96, 122, 124–5, 128
correlation 58
distribution 58

fluctuations 30, 33, 126–7
historical 124–5
implied 125–6
risk 126
smile 126
unconditional 124
white noise 49–50
Wiener process 15, 49–50, 79, 118, 128