

INDEX

A

Absolute risk, 2–3
Actual default estimates, risk-neutral
 default estimates (contrast), 169–170
Alpha, 104
Anchoring, 243–244
Annualization, 46–47
Artzner, Philippe, 73
Autoregressive conditional
 heteroskedasticity (ARCH) model, 37
Availability bias, 242–243
Averages, 16–21

B

Backtesting, 65–68, 79
Bayesian analysis, 205–229
Bayesian networks, 222–223, 224–227
Bayesians, frequentists (contrast), 213–214
Bayes, Thomas, 207
Bayes theorem, 208–213
Behavioral economics, risk
 (relationship), 231
Bernoulli, Daniel/Nicolas, 109
Beta distribution, 221f, 222
Beta, regression analysis 97
Biases
 and heuristics, 241–245
Bid-ask spread, 189, 197–198

Bid-offer spread, 189
Binomial distribution, 65, 68, 180, 216,
 221
Black Monday, 11–12, 18, 110
Bonds
 covenants, 184–185
 default, 170, 180
 default probability, sample problem,
 181–182
 expected value, determination (sample
 problem), 23–24
 five-year corporate bond default rate,
 173t
 Monte Carlo simulation, 182–183
 plain-vanilla bonds, 168
 portfolio, sample problem, 19
 pricing, 167–168
 ratings, 172t
 value, 168, 170–171
 zero-coupon bonds, 169
Bootstrapping, 60

C

Cash-flow uses, 190
Cash flow value at risk (CFVaR), 191
Causal reasoning, 223
CDF. *See* Cumulative distribution function
Central moments, 62

- Cholesky decomposition, 113–116
 sample problem, 116
- Clayton copulas, 253
- Clearinghouse 186
- Coefficient of determination, 103
- Coherent risk measures, 73–78
- Coin flip, expected value, 25
- Cokurtosis, 119–123
- Concordance, 142
- Conditional probability,
 78, 205–207
- Conditional risk, 2–3
- Conditional VaR (cVaR), 78
- Confidence interval, construction, 81
- Confidence level, 65
- Conjugate distributions, 222
- Continuous distributions, 125–126,
 218–222
 sample problem, 126, 219–220,
 221–222
- Continuous joint distribution, 124
- Continuous random variables,
 19–20
 median, 20
 mode, 20
- Contour graph, usage, 127
- Copulas, 132–146, 253–255
 Clayton copulas, 133f, 253
 data sets, comparison, 141t
 defining, 132–137
 density function, 136
 Farlie-Gumbel-Morgenstern (FGM)
 copula, 140, 253
 Frank's copula, 134, 138f, 254
 graphing, 137–139
 Gumbel copula, 133–134, 254
 independent copula, 150, 255, 278
 Joe copula, 255
 parameterization, 140–146
 sample problems, 134–136
- Cornish-Fisher VaR, 61–64, 81
 sample problem, 63–64
- Corporate bond default rate,
 173t, 173f
- Correlation, 91, 92–92, 112, 119,
 128–130
 matrices, Bayesian networks (contrast),
 224–227
 sample problem, 93
- Coskewness, 119–123
- Counterparty credit risk, 7
- Counterparty risk, 7
- Country risk, 151
- Covariance, 91–92
 calculation, 92, 115
 defining, 91, 112
 matrices, 113, 226f
- Crash of 1929, 11
- Credit risk, 7–8, 167–188
- Cross-central moments, 119
- Cumulative distribution function (CDF),
 82, 86, 125, 131, 136–138
 marginal CDF, calculation, 139
- Cumulative distributions, 134
- D**
- Data-generation process, constancy, 87
- Decay factor, 29–36
- Default
 Merton model, 177f
 modeling, 183
n defaults, probability, 179–182
 ratings approach, 171–174
 recovery, relationship, 168–169

- Default probability
 application, 174–175
 calculation, sample problem, 178
 determination, 171–179
 quantitative approach, 175–179
 sample problem, 181–182
- Default risk, 7, 169–171
- Delta, 63
- Delta-gamma approximation, accuracy, 64
- Delta-normal approach. *See* Delta-normal VaR
- Delta-normal VaR, 55–58, 112–113
 sample problem, 56
- Density function, 129
 calculation, 136–137
- De Ratiociniis in Ludo Aleae* (Huygens),
 10, 22
- Diagnostic reasoning, 223
- Discordance, 141
- Discount rate, 168
- Discrete distributions, 123–125
- Discrete random variables, 18–19
- Distance-to-default model, 175–177
- Distributions
 beta distribution, 221f
 continuous distributions, 125–126,
 218–222
 cumulative distributions, 134
 discrete distributions, 123–125
 extreme value theory distributions,
 83t, 85f
 Fréchet distribution, 83
 generalized Pareto distribution, 83t
 joint standard normal distribution,
 129f, 130
 marginal distributions, 129–132
 multivariate distributions, 123–132
 posterior distributions, 220f
 prior distributions, 220f
 univariate distributions, 133–134
 Weibull distribution, 84
- Disturbance terms, 37–38
- Diversification, 96, 151, 158–161,
 169–170
 diworsification, contrast, 159f
 index, 161
 score, 160–161
- Diworsification, 159–160
- Dollar standard deviation, 44–46
 sample problem, 45–46
- E**
- Economic agents, utility maximizers, 231
- Elasticity, equation, 198
- Endogenous liquidity models, 198–200
- Endowment effect, 244
- Enterprise risk, 8–9
- Enterprise value, 177–178
- Equities
 index, expected return, 29
 market risk, 151
- Equity premium puzzle, 237–238
- ESS. *See* Explained sum of squares
- Evidence, term (usage), 213
- EVT. *See* Extreme value theory
- Exceedances, 66–67
- Excess kurtosis, 43
- Exogenous liquidity models, 197–198
- Expectations, 21–26
 operator, usage, 23–24
- Expected shortfall, 73, 78–81
 example, 80f
 sample problem, 79
- Expected value, sample problem, 25–26

- Explained sum of squares (ESS), 103
 calculation, 108–109
- Exponentially weighted moving average (EWMA), 31–32
 characterization, half-life (usage), 33
 rectangular window, contrast, 32f, 33f
 weights, example, 32t
- Exposure-adjusted Black-Scholes-Merton Greeks, 62
- Extreme values, distributions, 82f
- Extreme value theory (EVT), 73, 81–88, 164
 distributions, 82, 83t, 85f
 results, interpretation, 86
 sample problem, 85–86
- Extrinsic risk, 3–4
- F**
- Factor analysis, 151–154
- Factor exposures, addition, 153t
- Farlie-Gumbel-Morgenstern (FGM) copula, 140, 144–146, 254
- F*-distribution, 109
- F*-distribution critical values, 110t
- FGM. *See* Farlie-Gumbel-Morgenstern
- Financial risk management
 defining, 4–6
- Financial Risk Manager (FRM) Exam, 13
 enrollment, 14f
- Fitch (rating agency), 172
- Frank's copula, 134, 138f, 254
- Frank's joint standard uniform PDF, 135f, 136–137
- Fréchet distribution, 83
- Frequentists, Bayesians (contrast), 213–214
- F*-statistic, 109
- G**
- Generalized autoregressive conditional heteroskedasticity (GARCH), 36–38, 123
 model, 43–44, 100
- Generalized Pareto distribution, 83t
- Global Association of Risk Professionals (GARP), founding, 13
- Goodwill, 175–176
- Great Depression, 11
- Great Recession, 11
- Gumbel copula, 84f, 133–134, 254
- H**
- Half-life, usage, 33
- Hedged portfolio, variance, 95
- Hedge ratio, 95
- Hedging, 93–96, 169–170
- Heuristic biases, 241–245
- Higher-order cross moments, 119, 123
- Historical simulation, 81
- Historical VaR, 56–58
- Huygens, Christiaan, 10
- Hybrid VaR, 58–59
- I**
- Idiosyncratic risk, 98, 105
- Incremental VaR (iVaR), 155–158
- Independence, testing, 131
- Independent and identically distributed (i.i.d.) random variables, 47, 95, 147–148
- Independent copula, 150, 255, 278
- Infinite series, weight, 34
- Interest-rate risk, 151
- Intrinsic risk, 3–4
- Isolines/isoquants, 128

J

Joe copula, 255
Joint cumulative distribution, 125
 function, 132
Joint distribution, shape, 164
Joint probabilities, 124t
 matrix, 125t
Joint probability density function (joint PDF), 275f
 defining, 126
 sample problem, 131–132
Joint standard normal distribution
 negative correlation, combination, 130f
 positive correlation, combination, 129f
Joint uniform probability density function (joint uniform PDF), 127f
JP Morgan, RiskMetrics spinoff, 12–13
Jump-diffusion model, 43–44
Junk bonds, 172

K

Kendall's tau, 141
 calculation, 142–143
 sample problem, 145–146
KMV, history, 179
Kurtosis, 41–43
 excess kurtosis, 43

L

Likelihood. *See* Maximum likelihood estimation
Likelihood, Bayesian, 213, 215
Linear regression analysis. *See* Regression analysis
Liquidity
 cost models, 196–200
 demand, 190–191

 endogenous liquidity models, 198–200
 exogenous liquidity models, 197–198
 internal demand, 190
 measures, 192–196
 schedule, 196
 sources, modeling difficulty, 191–192
 supply, 191–192
Liquidity-adjusted value at risk (LVaR), 196, 197
Liquidity at risk (LaR), 196
Liquidity risk. *See* liquidity.
London Interbank Offered Rate (LIBOR), 110, 168
Long-Term Capital Management (LTCM), 12
Loss aversion, 234–235, 235f
Loss given default (LGD), 169, 171
Low-probability events, perception, 238–239
LVaR. *See* Liquidity-adjusted value at risk

M

Marginal CDF, calculation, 139
Marginal distributions, 129–132
Marginal PDF, calculation, 131
Marginal utility, 233
Marked to model assets, 6
Market portfolio theory (MPT), 15
Market risk, 6–7, 15–150, 196
 correlation, 91, 119
 expected shortfall, 73
 extreme value theory, 73
 portfolios, 91
 risk attribution, 151
 standard deviation, 15
 stress testing, 73
 value at risk, 51

- Markowitz, Harry, 11, 15
- Maxima, and extreme value theory, 87
- Maximum likelihood estimation (MLE), 83, 140, 247–251
- Mean
 calculation, 17
 estimation, refinement, 34
 estimator, 35
- Median, calculation, 17
- Meriwether, John, 12
- Merton distance to default model.
 See Distance to default model
- Merton, Robert, 12, 175, 177, 184
- Mode, 17, 20
- Modern Portfolio Theory (MPT), 11
- Moments, 38
- Momentum, 151
- Monotonicity, 73–75
 sample problem, 74–75
- Monte Carlo simulation, 59–61, 78,
 113–116, 182–183
 creation, 113–114
 power, 609
 reduction, 61
 sample problem, 116
- Moody's (rating agency), 172
- Motorola, Six Sigma usage, 5
- Multicollinearity, 106–108
- Multi-period returns, generation, 60
- Multivariate distributions, 123–132
- Multivariate linear regression, 106–110
 evaluation, 108–110
 parameters, estimation, 108
- Multivariate regression, 106
 analysis, usage, 154
- Multivariate regressors, 97
- Municipal bonds, 167
- N**
- Negative correlation, joint standard normal distribution (combination), 130f
- Negative skewness, 39f
- Networks. *See* Bayesian networks
- Non-parametric distribution, 197
- Non-stationary variables, 46
- Nontrivial covariances, calculation, 113
- Nontrivial cross moments, 123t
- Normal variables, uniform variables
 transformation (correlation), 184f
- NORM.S.DIST function, usage, 138
- O**
- OLS. *See* Ordinary least squares
- One-year ratings transition matrix, 174t
- Operational risk, 8
- Optimal hedging, example, 101
- Optimal liquidation, 200–202, 201f
- Options
 Black-Scholes-Merton option pricing
 formula, usage, 177
 exposure-adjusted Black-Scholes-Merton
 Greeks, 62
 option-implied standard deviation,
 quoting, 47
- Ordinary least squares (OLS), 98–102
 assumptions, 106–108, 112
- Osband, Kent, 159
- Outlier, inclusion, 30f, 31f
- P**
- Parametric distribution, 87, 197
- Parsimony, 109
- Partial supply and demand curves, 199f
- Peaks-over-threshold (POT) approach,
 81, 85

- Pearson's correlation, 142
- Plateauing, EWMA (usage), 33–34
- Population
- data, 16–18
 - standard deviation, 43
- Portfolios, 91
- credit risk, 179–184
 - diversification, 78, 160
 - factor exposures, addition, 153t
 - hedged portfolio, variance, 95
 - managers, performance, 242
 - risk, coskewness/cokurtosis (impact), 133
 - total VaR, 156
 - variance/hedging, 93–96
 - VaR measurement, sample problem, 155
 - volatility, reduction, 96
- Positive homogeneity, 73, 75–76
- Posterior distributions, 218, 219, 220f
- Posterior probabilities, 216
- POT. *See* Peaks-over-threshold
- Prior distributions, 220f
- Probability density function (PDF), 19–20, 21f, 181, 248
- binomial probability density function, 182f
 - bivariate standard normal PDF, 127f, 128f, 133f, 138f
 - Frank's joint standard uniform PDF, 135f
 - Fréchet probability density functions (Fréchet PDFs), 83f
 - Gumbel probability density functions, 84f
 - joint uniform probability density function, 127f
 - marginal PDF, calculation, 131
 - sample problem, 20–21, 53–54
 - triangular PDF, 53f, 80f
 - Weibull probability density functions (Weibull PDFs), 84f
- R**
- RAND function, 183
- Rating agencies, 171–172
- Ratings approach, 171–174
- Recovery, default, 168–169
- Rectangular weights, EWMA (contrast), 32f
- Rectangular window, EWMA (contrast), 33f
- Regression analysis, 96–110
- Relative risk, 2–3
- Relative utility, 239–241
- Representativeness, 241–242
- Residual sum of squares (RSS), 102, 108–109
- RiskMetrics, 12–13
- R*-squared, 103, 105–106, 109
- RSS. *See* Residual sum of squares
- S**
- Sample data, 16–18
- Sampling, with replacement, 60
- Scholes, Myron, 12
- Securities and Exchange Commission (SEC), establishment, 11
- Settlement risk, 8
- Sharpe ratio, 162–163
- Sharpe, William, 162
- Skewness, 38–41
- Sovereign bonds, default risk, 167
- Spearman's rho, 141, 146

- Square-root rule, 94–95
- Standard deviation, 4, 15–16, 26–28, 58
 decay, impact, 29–36
 dollar standard deviation, 44–46
- Standard & Poor's (rating agency), 172
- Stationary variables, usage, 46
- Stock-specific risk, 154
- Stress testing, 73, 110–112
- Student's t -distribution, 83–84
- Style risk, 151
- Subadditive risk measures, 77
- Subadditivity, 73, 77–78
 sample problem, 77–78
- Sum of squared residuals, 102
- T**
- Theta, 55, 63
- Total sum of squares (TSS), 103
 calculation, 108–109
- Transition matrices, 174–175
 five-year ratings transition matrix, 175t
 one-year ratings transition matrix, 174t
- Translation invariance, 73, 76–77
- Triangular PDF, 53f, 80f
- TSS. *See* Total sum of squares
- t -statistics, usage, 104–105
- Twain, Mark, 111
- U**
- Uniform variables, correlation, 184f
- Univariate distributions, 133–134
- Univariate linear regression,
 96–106
 parameters, estimation, 102–103
 regression, evaluation, 103–106
- Utility functions, 231–235, 232f
 loss aversion, 234–235
 sample problem, 233–234
- Utility under uncertainty, 236–241
 sample problem, 236–237
- V**
- Value at risk (VaR), 51, 80f
 95% historical VaR, example, 57t
 95% hybrid VaR, example, 59t
 95% VaR, example, 52f
 backtesting, 87
 calculation, 74
 conditional VaR (cVaR), 78
 Cornish-Fisher VaR, 61–64
 defining, 51–54
 delta-normal VaR, 55–56
 estimation, 113
 exceedance, probability, 68
 historical VaR, 56–58
 hybrid VaR, 58–59
 incremental VaR, 155–158
 measurement, sample problem, 155
 models, 67, 68
- Variables
 continuous random variables, 19–20
 discrete random variables, 18–19
 distributions, 34–35
 joint distribution, 225
 linear combination, 108
 product, expected value, 25
- Variance
 calculation/equation, 28
 long-run variance, 37
 standard deviation, relationship, 26–28
 standard estimator, 35
- Vitruvius, 1

Volatility (vol), 15–16, 44

low level, 61

reduction, 96

Volume-weighted average price (VWAP),

200

W

Weibull distribution, 84

Weibull probability density functions

(Weibull PDFs), 84f

Weighted less squares (WLS) regression,

112

Window length, 31

Y

Yield, 170–171

Z

Zero-coupon bonds,

169, 171

