Tables and Figures

Figure 1.1  Comparative simugrams for 10-year terminal value for T-bill and Dow 30 account, M=10,000 simulations. 14

Figure 1.2  Stochastic ordering of T-bill and Dow-stock accounts based on simugrams in figure 1.1 above. 15

Table 1.1, Annual S&P Index Changes 17

Table 1.2, Permitted Vector Operations 18

Table 1.3, Resulting GBM Parameters for Geoindex Operations 21

Figure 1.3  GBM parameter estimates for geoindex vs. dowindex; M=10,000 simulations, each process simulated GBM of length 5,000. 23

Table 1.4  Comparison of returns, SP-500 vs. 1 year Treasury Bills, 1965-2000. Assumes all principal reinvested. 26

Figure 1.4  Comparison of returns, SP-500 vs. 1 year Treasury Bills (Top panel); the bottom panel shows the cumulative percentage outperformance of the SP-500 vs. T-bills for the same period. 27

Figure 1.5  SP-100 simugram returns vs. SP-500 market returns; 105 simugram trials for each of years 1970-2002. 28

Figure 2.1  Illustration of objective function as applied to two different portfolios. 34

Figure 2.2  Flowchart for Simugram Weight Optimization 36

Table 2.1  SP-100 baseline results, constraint set 0 (CS0). 37

Table 2.2  SP-500 unusual year summary, by return. 41

Table 2.3  Table of correlations, market indexes and SP-100 simugram results. 42

Table 2.4  Performance summary 43

Figure 2.3. SP-500 simugram weighted investment, log10 scale 47

Figure 2.4. Comparison of OEX and SP-100 simugram weights, log10 scale 47
Table 2.5  SP-100 viable symbol sampling results, 1974 and 1992

Table 2.6  SP-100 viable symbol time-persistence pattern, 1970-1980

Figure 2.5  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by allocation, 1970-1977.

Figure 2.6  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by allocation, 1978-1985.

Figure 2.7  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by allocation, 1986-1993.

Figure 2.8  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by allocation, 1994-2002.

Figure 2.9  Unscaled (ACS) plot, T cutoff by allocation, 1977, 79, 88, 94, 97.

Table 2.7  SP100 Simugram Returns by Allocation - Larger Max Allocations. Constraint set: optimization method: nonparametric, One group; portfolio size: 59-99; projected distribution time (years): 1; initialization: EW; maximization criteria: median; simulations: 1000; minimum risk percentile: 20; minimum risk return: 1.05; max allocation: various.

Figure 2.10  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by r*, 1970-1977.

Figure 2.11  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by r*, 1978-1993.

Figure 2.12  SP-100 simugram alternate constraint set (ACS) plot, T cutoff by r*, 1994-2002.

Figure 2.13  Unscaled (ACS) plot, T cutoff by r*, 1975, 77, 84, 88, 90.

Figure 2.14  SP-100 Simugram ACS, unscaled, T cutoff by r*, 1975

Table 2.8  Tail Cutoff 10% Constraint violations, decreasing magnitude

Table 2.9  Optional r* for SP-100 by year

Figure 2.15  SP-100 simugram alternate constraint set (ACS) plot, Percent r* by allocation, 1970-1977.
Figure 2.16  SP-100 simugram alternate constraint set (ACS) plot, Percent r* by allocation, 1978-1993.

Figure 2.17  SP-100 simugram alternate constraint set (ACS) plot, Percent r* by allocation, 1994-2002.

Table 2.10  Alternate constraint set anomalous year summary and diagnosis.

Table 2.11  SP-100 simugram sampling study, baseline CS0 results.

Table 2.12  Simugram volatility by year and the SP-500 returns

Table 2.13  Summary results, SP-100 simugram portfolio vs. market, 1970-2002

Table 2.14  SP-100 simugram sampling study, CS20-25-30 summary results

Table 2.15  Summary results, SP-100 simugram portfolio vs. market, 1970-2002

Figure 2.18  Distribution of Terminal Values, CS0-CS30, with Q-Q Plots

Figure 2.19  Example of non-normal return, 1990

Figure 2.20  Diagnostics of Simugram Returns not appearing Normal

Table 2.16  SP-100 CS0 annual returns, goodness of fit tests for normality

Figure 2.21  Diagnostics of Typical Simugram Returns, higher allocations

Table 2.17  SP-100 Simulation size tests (M-tests), 1974, 1986-87.

Figure 2.22  Return Variation as a function of simulations, M=1,000 or 5,000

Table 2.18  SP-100 simulation size tests, 1998, M=1000/5000/10000

Figure 2.23  Simugram M-tests, N=100, showing sorted returns from M=1000 or M=5000

Table 2.19  SP-100 M-tests, 1999, Gaussian parameters and their estimates

Table 2.20  SP-100 M-tests, 1999, CS30

Figure 2.24  Simugram M-tests and boxplots, 1999, showing the parameter change associated with higher M.
Table 2.21  SP-100 M-tests, 1999, CS25, with range of M

Figure 2.25  Convergence time (on a fast processor) for the Nelder-Mead routine as a function of portfolio dimension.

Table 3.1  SP-500 Baseline Results, and performance comparison, constraint set 0.

Figure 3.1  Cumulative performance of SP-500 vs. SP-100 simugram

Table 3.2  Mean simugram returns by initial weight vector, EW vs. MC. Sample size is 11 for the market-cap initial weights, and 105 for the equal-weight initialization vector.

Table 3.3  SP-500 simugram, CS0, DAC-2, sum(w)=2

Table 3.4  SP-500 simugram, CS25, DAC-2, sum(w)=2

Table 3.5  SP-500 simugram, comparison DAC-2 Sum2, DAC-2 Sum1

Table 3.6  SP-500 simugram, DAC-2, DAC-3 comparisons. Samples in CS0, DAC-3 108

Table 3.7  Summary results, SP-500 vs. SP-100 simugram vs. market, 1977-2002

Table 3.8  SP-500 simugram, comparison DAC-1/DAC-2/DAC-3, DAC-5 Sum5. Samples in DAC-5 CS0: 12.5, and in CS25: 2.9.

Table 3.9  SP-500 simugram, comparison DAC-1/DAC-2/DAC-3/DAC-5 Sum5. and ReDAC. Samples in DAC-5 CS0: 12.5, and in CS25: 2.9. Samples in ReDAC CS0: 16.5; CS25: 5.7

Table 3.10  SP-500 simugram, CS0, comparison DAC-1/DAC-2/DAC-5 and ReDAC, 112

Table 3.11 Summary results, SP-500/100 Simugram vs. market and themselves, 1977-2002.

Figure 3.3  Simugram Outperformance of SP-500 SPX market index, and Opportunity cost

Table 4.1  Market benchmark outperformance by Simugram portfolios, 33- and 26-years study periods

Table 4.2  Trading statistics for the simugram portfolios
Table 4.3  Simugram portfolio correlation with market indexes

Figure 4.1  Simugram for null hypothesis distribution, M=1.000 Simulations of terminal value, N=33 years, for both Wilshire 5000 and the Dow 30.

Figure 4.2  Annual cumulative percentage outperformance for the SP-500 (SPX) and Wilshire-5000 (TMW) against the SP-100 (OEX), 1977-2002.

Figure 4.3  Daily cumulative percentage outperformance for the DOW, SPX and TMW against OEX, 1983-2002.

Table 4.4  Summary statistics for daily returns of TMW, SPX, DOW, OEX and the Geoindex, 1983-2002.

Table 4.5  Two-Sample Kolmogorov-Smirnov tests for common distribution for TMW, SPX, DOW, OEX, the Geoindex, 1983-2002.

Table 4.6  Costs to hedge, 33 years, 13-month vanilla SPX index vs. single stock options

Table 4.7  Effect of 1 bad year, SP-500 and Simugram 33-year terminal value, unhedged vs. hedged with SPX index options

Table 4.8  Effect of 1 bad year, SP-500 and Simugram 33-year terminal value, unhedged vs. hedged with single stock options

Table 4.9  Effect of 2 consecutive bad years; SP-500 and Simugram 33-year terminal value, unhedged vs. hedged with SPX index or single stock options

Table D.1, SP-100 Simugram Review of Returns

Table D.2, SP-100 Simugram Volatility of Returns

Table D.3, SP-500 Simugram Volatility of Returns

Table E.1  Graphical Return Summary, SP-100 Simugram Returns, CS0

Table E.2  Graphic Return Summary, SP-500 Simugram Returns, CS0

Table F.1  Summary results, SP-500 vs. SP-100 simugram vs. market, including DAC-4

Table F.2  Epilogue comparative results for DAC-k, Sum 1

Table F.3  Epilogue comparative results for DAC-k Sum 4, and ReDAC

Table F.4  Simugram Comparative results for 2003, CS0

Table F.5  Epilogue Comparative results, 1977-2003, CS0
Contents

Abstract ii

Acknowledgments iv

List of Tables and Figures vii

1. Foundations 1

1.1 Problem Statement 1

1.2 A Note on Returns 7

1.3 The Simugram 11

1.4 Role of the Geometric Index 15

1.5 Market Performance and Outperformance 24

2. Methodology 29

2.1 Data 29

2.2 The Stochastic Simulation Problem 31

2.3 Objective Function 33

2.4 Baseline Results for S&P 100 36

2.4.1 Exploratory Data Analysis (EDA) 38

2.4.2 Characteristics of Simugram Weights 45

2.5 Constraints 52

2.5.1 Alternate Constraint Set (ACS) - Maximum Allocation by Tail Cutoff. 53

2.5.2 Alternate Constraint Set (ACS) - Risk Percentile (r*) 60

2.5.3 Alternate Constraint Set (ACS) - Minimum return/risk tolerance r_tail 68

2.6 Sampling Studies 71

2.6.1 SP-100 Multiple Trial Sampling 72
Appendix C. Transformation Reduction on Nelder Mead Convergence Time 159
Appendix D. Volatility Table for Simugram Sample Returns 160
Appendix E. Graphical Return Summary, SP-100 and SP-500 163
Appendix F. Epilogue: DAC-4 and 2003 Results 165