

Overview of PerformanceAnalytics' Charts and Tables

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Outline

Introduction

Set Up PerformanceAnalytics

Review Performance

Summary

Overview

- ▶ Utilize charts and tables to display and analyze data:
 - ▶ asset returns
 - ▶ compare an asset to other similar assets
 - ▶ compare an asset to one or more benchmarks
- ▶ Utilize common performance and risk measures to aid the investment decision
- ▶ Examples developed using data for six (hypothetical) managers, a peer index, and an asset class index
- ▶ Hypothetical manager data developed from real manager timeseries using *accuracy* and *perturb* packages to perturb data maintaining the statistical distribution properties of the original data.

Install PerformanceAnalytics.

- ▶ As of version 0.9.4, PerformanceAnalytics is available in CRAN
- ▶ Version 0.9.5 was released at the beginning of July
- ▶ Install with:

```
> install.packages("PerformanceAnalytics")
```
- ▶ Required packages include Hmisc, zoo, and Rmetrics packages such as fExtremes.
- ▶ Load the library into your active R session using:

```
> library("PerformanceAnalytics").
```

Load and Review Data.

```
> data(managers)
```

```
> head(managers)
```

	HAM1	HAM2	HAM3	HAM4	HAM5	HAM6	EDHEC	LS	EQ	SP500	TR
1996-01-31	0.0074	NA	0.0349	0.0222	NA	NA			NA	0.0340	
1996-02-29	0.0193	NA	0.0351	0.0195	NA	NA			NA	0.0093	
1996-03-31	0.0155	NA	0.0258	-0.0098	NA	NA			NA	0.0096	
1996-04-30	-0.0091	NA	0.0449	0.0236	NA	NA			NA	0.0147	
1996-05-31	0.0076	NA	0.0353	0.0028	NA	NA			NA	0.0258	
1996-06-30	-0.0039	NA	-0.0303	-0.0019	NA	NA			NA	0.0038	
	US 10Y TR	US 3m TR									
1996-01-31	0.00380	0.00456									
1996-02-29	-0.03532	0.00398									
1996-03-31	-0.01057	0.00371									
1996-04-30	-0.01739	0.00428									
1996-05-31	-0.00543	0.00443									
1996-06-30	0.01507	0.00412									

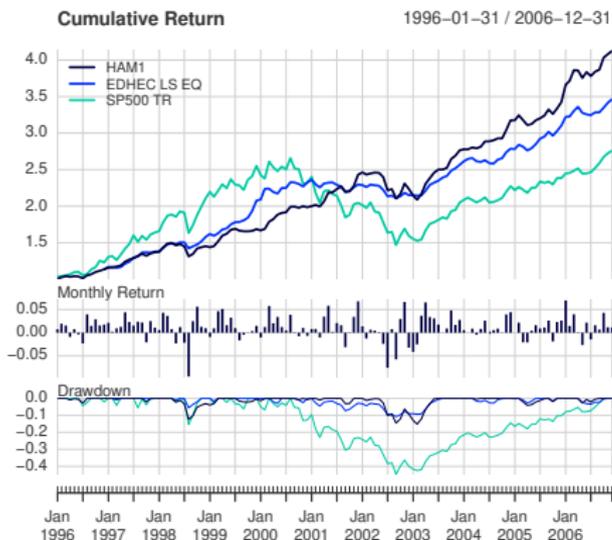
Set Up Data for Analysis.

```
> dim(managers)
[1] 132  10
> managers.length = dim(managers)[1]
> colnames(managers)
 [1] "HAM1"          "HAM2"          "HAM3"          "HAM4"          "HAM5"
 [6] "HAM6"          "EDHEC LS EQ"  "SP500 TR"      "US 10Y TR"     "US 3m TR"
> manager.col = 1
> peers.cols = c(2,3,4,5,6)
> indexes.cols = c(7,8)
> Rf.col = 10
> #factors.cols = NA
> trailing12.rows = ((managers.length - 11):managers.length)
> trailing12.rows
 [1] 121 122 123 124 125 126 127 128 129 130 131 132
> trailing36.rows = ((managers.length - 35):managers.length)
> trailing60.rows = ((managers.length - 59):managers.length)
> #assume contiguous NAs - this may not be the way to do it na.contigu
> frInception.rows = (length(managers[,1]) -
+ length(managers[,1][!is.na(managers[,1])]) + 1):length(managers[,1])
```

Draw a Performance Summary Chart.

```
> charts.PerformanceSummary(managers[,c(manager.col,indexes.cols)],  
+ colorset=rich6equal, lwd=2, ylog=TRUE)
```

HAM1 Performance



Show Calendar Performance.

```
> t(table.CalendarReturns(managers[,c(manager.col,indexes.cols)]))
```

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Jan	0.7	2.1	0.6	-0.9	-1.0	0.8	1.4	-4.1	0.5	0.0	6.9
Feb	1.9	0.2	4.3	0.9	1.2	0.8	-1.2	-2.5	0.0	2.1	1.5
Mar	1.6	0.9	3.6	4.6	5.8	-1.0	0.6	3.6	0.9	-2.1	4.0
Apr	-0.9	1.3	0.8	5.1	2.0	3.5	0.5	6.5	-0.4	-2.1	-0.1
May	0.8	4.4	-2.3	1.6	3.4	5.8	-0.1	3.4	0.8	0.4	-2.7
Jun	-0.4	2.3	1.2	3.3	1.2	0.2	-2.4	3.1	2.6	1.6	2.2
Jul	-2.3	1.5	-2.1	1.0	0.5	2.1	-7.6	1.8	0.0	0.9	-1.4
Aug	4.0	2.4	-9.4	-1.7	3.9	1.6	0.8	0.0	0.5	1.1	1.6
Sep	1.5	2.2	2.5	-0.4	0.1	-3.1	-5.8	0.9	0.9	2.6	0.7
Oct	2.9	-2.1	5.6	-0.1	-0.8	0.1	3.0	4.8	-0.1	-1.9	4.3
Nov	1.6	2.5	1.3	0.4	1.0	3.4	6.6	1.7	3.9	2.3	1.2
Dec	1.8	1.1	1.0	1.5	-0.7	6.8	-3.2	2.8	4.4	2.6	1.1
HAM1	13.6	20.4	6.1	16.1	17.7	22.4	-8.0	23.7	14.9	7.8	20.5
EDHEC LS EQ	NA	21.4	14.6	31.4	12.0	-1.2	-6.4	19.3	8.6	11.3	11.7
SP500 TR	23.0	33.4	28.6	21.0	-9.1	-11.9	-22.1	28.7	10.9	4.9	15.8

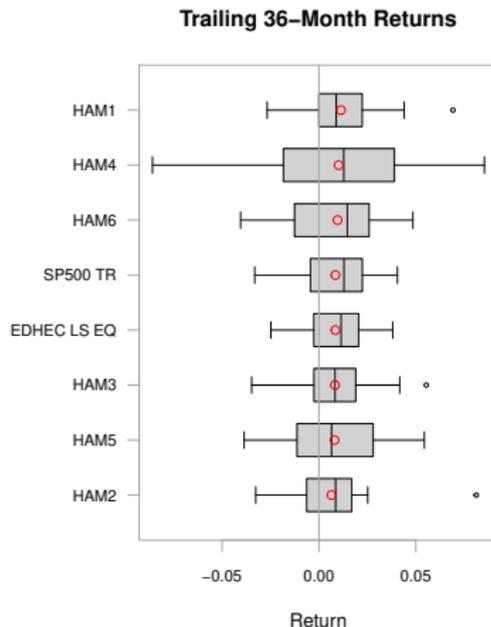
Calculate Statistics.

```
> table.Stats(managers[,c(manager.col,peers.cols)])
```

	HAM1	HAM2	HAM3	HAM4	HAM5	HAM6
Observations	132.0000	125.0000	132.0000	132.0000	77.0000	64.0000
NAs	0.0000	7.0000	0.0000	0.0000	55.0000	68.0000
Minimum	-0.0944	-0.0371	-0.0718	-0.1759	-0.1320	-0.0404
Quartile 1	0.0000	-0.0098	-0.0054	-0.0198	-0.0164	-0.0016
Median	0.0112	0.0082	0.0102	0.0138	0.0038	0.0128
Arithmetic Mean	0.0111	0.0141	0.0124	0.0110	0.0041	0.0111
Geometric Mean	0.0108	0.0135	0.0118	0.0096	0.0031	0.0108
Quartile 3	0.0248	0.0252	0.0314	0.0460	0.0309	0.0255
Maximum	0.0692	0.1556	0.1796	0.1508	0.1747	0.0583
SE Mean	0.0022	0.0033	0.0032	0.0046	0.0052	0.0030
LCL Mean (0.95)	0.0067	0.0076	0.0062	0.0019	-0.0063	0.0051
UCL Mean (0.95)	0.0155	0.0206	0.0187	0.0202	0.0145	0.0170
Variance	0.0007	0.0013	0.0013	0.0028	0.0021	0.0006
Stdev	0.0256	0.0367	0.0365	0.0532	0.0457	0.0238
Skewness	-0.6588	1.4580	0.7908	-0.4311	0.0738	-0.2800
Kurtosis	2.3616	2.3794	2.6829	0.8632	2.3143	-0.3489

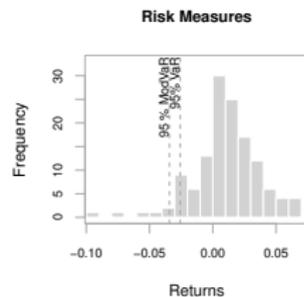
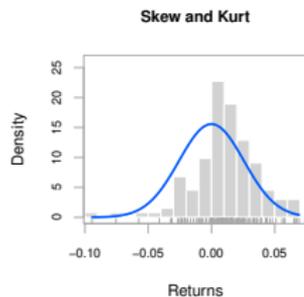
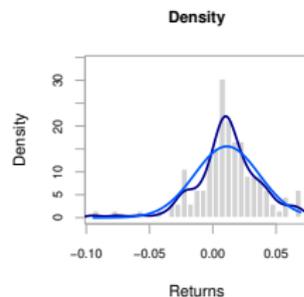
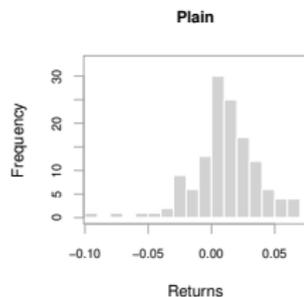
Compare Distributions.

```
> chart.Boxplot(managers[ trailing36.rows, c(manager.col, peers.cols,  
+ indexes.cols)], main = "Trailing 36-Month Returns")
```



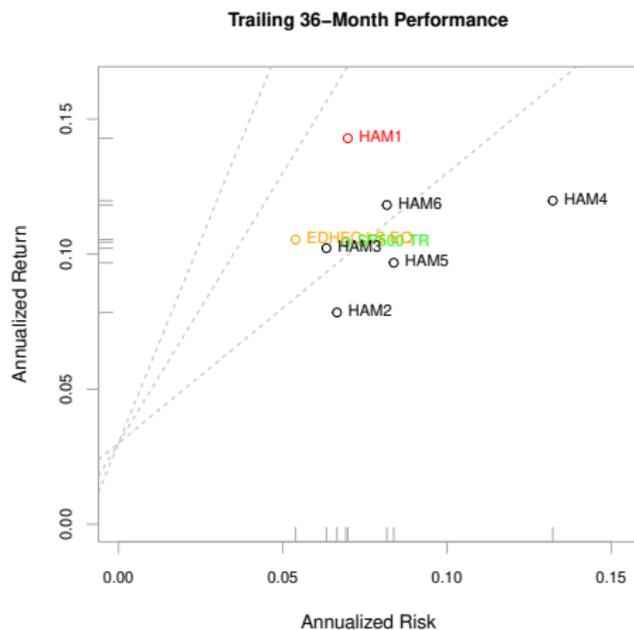
Compare Distributions.

```
> layout(rbind(c(1,2),c(3,4)))  
> chart.Histogram(managers[,1,drop=F], main = "Plain", methods = NULL)  
> chart.Histogram(managers[,1,drop=F], main = "Density", breaks=40,  
+ methods = c("add.density", "add.normal"))  
> chart.Histogram(managers[,1,drop=F], main = "Skew and Kurt", methods = c  
+ ("add.centered", "add.rug"))  
> chart.Histogram(managers[,1,drop=F], main = "Risk Measures", methods = c  
+ ("add.risk"))
```



Show Relative Return and Risk.

```
> chart.RiskReturnScatter(managers[trailing36.rows,1:8], Rf=.03/12, ma
+ "Trailing 36-Month Performance", colorset=c("red", rep("black",5), "
+ "green"))
```



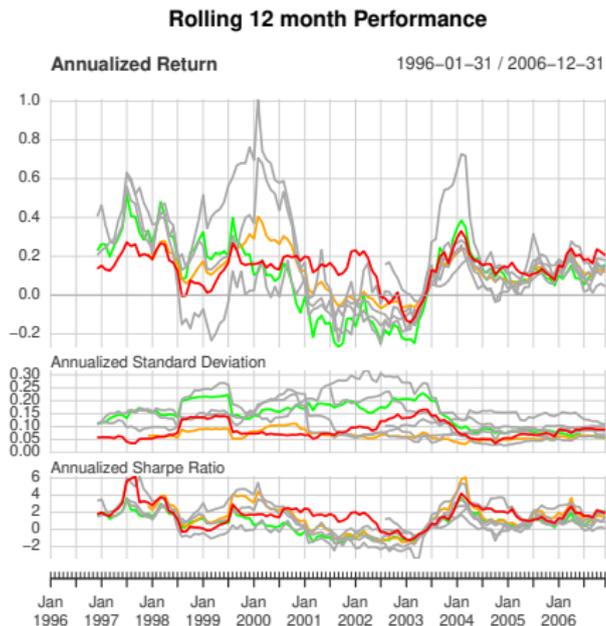
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	HAM1	HAM2	HAM3	HAM4	HAM5	HAM6
Observations	132.0000	125.0000	132.0000	132.0000	77.0000	64.0000
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Minimum	-0.0944	-0.0371	-0.0718	-0.1759	-0.1320	-0.0404
Quartile 1	0.0000	-0.0098	-0.0054	-0.0198	-0.0164	-0.0016
Median	0.0112	0.0082	0.0102	0.0138	0.0038	0.0128
Arithmetic Mean	0.0111	0.0141	0.0124	0.0110	0.0041	0.0111
Geometric Mean	0.0108	0.0135	0.0118	0.0096	0.0031	0.0108
Quartile 3	0.0248	0.0252	0.0314	0.0460	0.0309	0.0255
Maximum	0.0692	0.1556	0.1796	0.1508	0.1747	0.0583
SE Mean	0.0022	0.0033	0.0032	0.0046	0.0052	0.0030
LCL Mean (0.95)	0.0067	0.0076	0.0062	0.0019	-0.0063	0.0051
UCL Mean (0.95)	0.0155	0.0206	0.0187	0.0202	0.0145	0.0170
Variance	0.0007	0.0013	0.0013	0.0028	0.0021	0.0006
Stdev	0.0256	0.0367	0.0365	0.0532	0.0457	0.0238
Skewness	-0.6588	1.4580	0.7908	-0.4311	0.0738	-0.2800
Kurtosis	2.3616	2.3794	2.6829	0.8632	2.3143	-0.3489

Examine Performance Consistency.

```
> charts.RollingPerformance(managers[, c(manager.col, peers.cols,  
+ indexes.cols)], Rf=.03/12, colorset = c("red", rep("darkgray",5), "o  
+ "green"), lwd = 2)
```



Display Relative Performance.

```
> chart.RelativePerformance(managers[, manager.col, drop = FALSE],  
+ managers[, c(peers.cols, 7)], colorset = tim8equal[-1], lwd = 2, lty  
+ = "topleft")
```



Compare to a Benchmark.

```
> chart.RelativePerformance(managers[, c(manager.col, peers.cols) ],  
+ managers[, 8, drop=F], colorset = rainbow8equal, lwd = 2, legend.loc  
+ "topleft")
```



Compare to a Benchmark.

```
> if(requireNamespace("RobStatTM", quietly = TRUE)) { # CRAN requires conditional execution
+   table.CAPM(managers[trailing36.rows, c(manager.col, peers.cols)], managers[ trailing36.rows,
+ ] }
```

	HAM1 to SP500 TR	HAM2 to SP500 TR	HAM3 to SP500 TR
Alpha	0.0051	0.0020	0.0020
Beta	0.6267	0.3223	0.6320
Alpha Robust	0.0041	0.0028	0.0019
Beta Robust	0.5646	0.2652	0.6245
Beta+	0.8227	0.4176	0.8240
Beta-	1.1218	-0.0483	0.8291
Beta+ Robust	0.7297	0.3762	0.7968
Beta- Robust	1.1293	0.3331	0.8417
R-squared	0.3829	0.1073	0.4812
R-squared Robust	0.3525	0.0777	0.4585
Annualized Alpha	0.0631	0.0247	0.0243
Correlation	0.6188	0.3276	0.6937
Correlation p-value	0.0001	0.0511	0.0000
Tracking Error	0.0604	0.0790	0.0517
Active Premium	0.0384	-0.0260	-0.0022
Information Ratio	0.6363	-0.3295	-0.0428
Treynor Ratio	0.1741	0.1437	0.1101
	HAM4 to SP500 TR	HAM5 to SP500 TR	HAM6 to SP500 TR
Alpha	0.0009	0.0002	0.0022
Beta	1.1282	0.8755	0.8150
Alpha Robust	0.0012	0.0002	0.0027
Beta Robust	1.1175	0.8759	0.8325
Beta+	1.8430	1.0985	0.9993
Beta-	1.2223	0.5283	1.1320
Beta+ Robust	1.8473	1.0967	1.0291
Beta- Robust	1.2206	0.5038	1.1349
R-squared	0.3444	0.5209	0.4757
R-squared Robust	0.3510	0.5590	0.4780
Annualized Alpha	0.0109	0.0030	0.0271
Correlation	0.5868	0.7218	0.6897
Correlation p-value	0.0002	0.0000	0.0000

table.CAPM underlying techniques

- ▶ Return.annualized — Annualized return using

$$\text{prod}(1 + R_a)^{\frac{\text{scale}}{n}} - 1 = \sqrt[n]{\text{prod}(1 + R_a)^{\text{scale}}} - 1 \quad (1)$$

- ▶ TreynorRatio — ratio of asset's Excess Return to Beta β of the benchmark

$$\frac{(\overline{R_a - R_f})}{\beta_{a,b}} \quad (2)$$

- ▶ ActivePremium — investment's annualized return minus the benchmark's annualized return
- ▶ Tracking Error — A measure of the unexplained portion of performance relative to a benchmark, given by

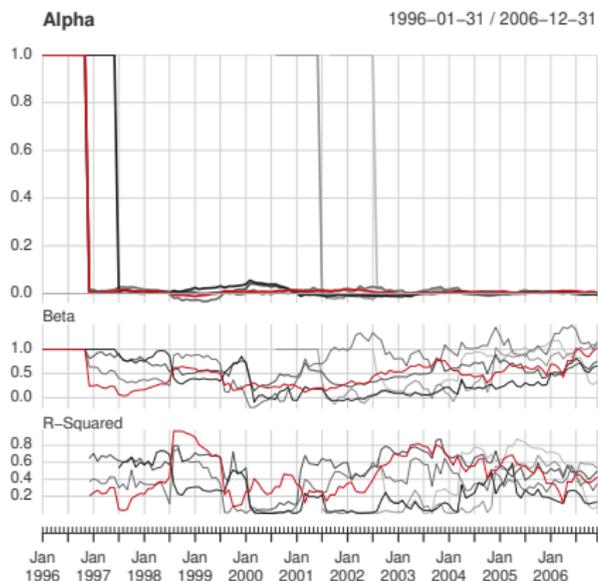
$$\text{TrackingError} = \sqrt{\sum \frac{(R_a - R_b)^2}{\text{len}(R_a) \sqrt{\text{scale}}}} \quad (3)$$

- ▶ InformationRatio — ActivePremium/TrackingError

Compare to a Benchmark.

```
> #source("PerformanceAnalytics/R/Return.excess.R")  
> charts.RollingRegression(managers[, c(manager.col, peers.cols), drop  
+ FALSE], managers[, 8, drop = FALSE], Rf = .03/12, colorset = redfocu  
+ 2)
```

Rolling 12-month Regressions



Calculate Downside Risk.

```
> table.DownsideRisk(managers[,1:6],Rf=.03/12)
```

	HAM1	HAM2	HAM3	HAM4	HAM5
Semi Deviation	0.0191	0.0201	0.0237	0.0395	0.0324
Gain Deviation	0.0169	0.0347	0.0290	0.0311	0.0313
Loss Deviation	0.0211	0.0107	0.0191	0.0365	0.0324
Downside Deviation (MAR=10%)	0.0178	0.0164	0.0214	0.0381	0.0347
Downside Deviation (Rf=3%)	0.0154	0.0129	0.0185	0.0353	0.0316
Downside Deviation (0%)	0.0145	0.0116	0.0174	0.0341	0.0304
Maximum Drawdown	0.1518	0.2399	0.2894	0.2874	0.3405
Historical VaR (95%)	-0.0258	-0.0294	-0.0425	-0.0799	-0.0733
Historical ES (95%)	-0.0513	-0.0331	-0.0555	-0.1122	-0.1023
Modified VaR (95%)	-0.0342	-0.0276	-0.0368	-0.0815	-0.0676
Modified ES (95%)	-0.0610	-0.0614	-0.0440	-0.1176	-0.0974

Semivariance and Downside Deviation

- ▶ Downside Deviation as proposed by Sharpe is a generalization of semivariance which calculates bases on the deviation below a Minimumn Acceptable Return(MAR)

$$\delta_{MAR} = \sqrt{\frac{\sum_{t=1}^n (R_t - MAR)^2}{n}} \quad (4)$$

- ▶ Downside Deviation may be used to calculate semideviation by setting MAR=mean(R) or may also be used with MAR=0
- ▶ Downside Deviation (and its special cases semideviation and semivariance) is useful in several performance to risk ratios, and in several portfolio optimization problems.

Value at Risk

- ▶ Value at Risk (VaR) has become a required standard risk measure recognized by Basel II and MiFID
- ▶ traditional mean-VaR may be derived historically, or estimated parametrically using

$$z_c = q_p = qnorm(p) \quad (5)$$

$$VaR = \bar{R} - z_c \cdot \sqrt{\sigma} \quad (6)$$

- ▶ even with robust covariance matrix or Monte Carlo simulation, mean-VaR is not reliable for non-normal asset distributions
- ▶ for non-normal assets, VaR estimates calculated using GPD (as in VaR.GPD) or Cornish Fisher perform best
- ▶ modified Cornish Fisher VaR takes higher moments of the distribution into account:

$$z_{cf} = z_c + \frac{(z_c^2 - 1)S}{6} + \frac{(z_c^3 - 3z_c)K}{24} + \frac{(2z_c^3 - 5z_c)S^2}{36} \quad (7)$$

$$modVaR = \bar{R} - z_{cf}\sqrt{\sigma} \quad (8)$$

- ▶ modified VaR also meets the definition of a coherent risk measure per Artzner,et.al.(1997)

Risk/Reward Ratios in *PerformanceAnalytics*

- ▶ SharpeRatio — return per unit of risk represented by variance, may also be annualized by

$$\frac{\sqrt[n]{\text{prod}(1 + R_a)^{\text{scale}} - 1}}{\sqrt{\text{scale} \cdot \sigma}} \quad (9)$$

- ▶ Sortino Ratio — improvement on Sharpe Ratio utilizing downside deviation as the measure of risk

$$\frac{(\overline{R_a - MAR})}{\delta_{MAR}} \quad (10)$$

- ▶ Calmar and Sterling Ratios — ratio of annualized return (Eq. 1) over the absolute value of the maximum drawdown
- ▶ Sortino's Upside Potential Ratio — upside semdeviation from MAR over downside deviation from MAR

$$\frac{\sum_{t=1}^n (R_t - MAR)}{\delta_{MAR}} \quad (11)$$

- ▶ Favre's modified Sharpe Ratio — ratio of excess return over Cornish-Fisher VaR

$$\frac{(\overline{R_a - R_f})}{\text{modVaR}_{R_a, p}} \quad (12)$$

- ▶ *NOTE:* The newest measures such as modified Sharpe and Sortino's UPR are far more reliable than older measures, but everyone still seems to look at older measures.

Summary

- ▶ Performance and Risk analysis are greatly facilitated by the use of charts and tables.
- ▶ The display of your information is in many cases as important as the analysis.
- ▶ The observer should have gained a working knowledge of how specific visual techniques may be utilized to aid investment decision making.
- ▶ Further Work
 - ▶ Additional parameterization to make charts and tables more useful.
 - ▶ Pertrac or Morningstar-style sample reports.
 - ▶ Functions and graphics for more complicated topics such as factor analysis and optimization.

