Overview of PerformanceAnalytics' Charts and Tables

Brian G. Peterson

Diamond Management & Technology Consultants
Chicago, IL
brian@braverock.com

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Outline

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

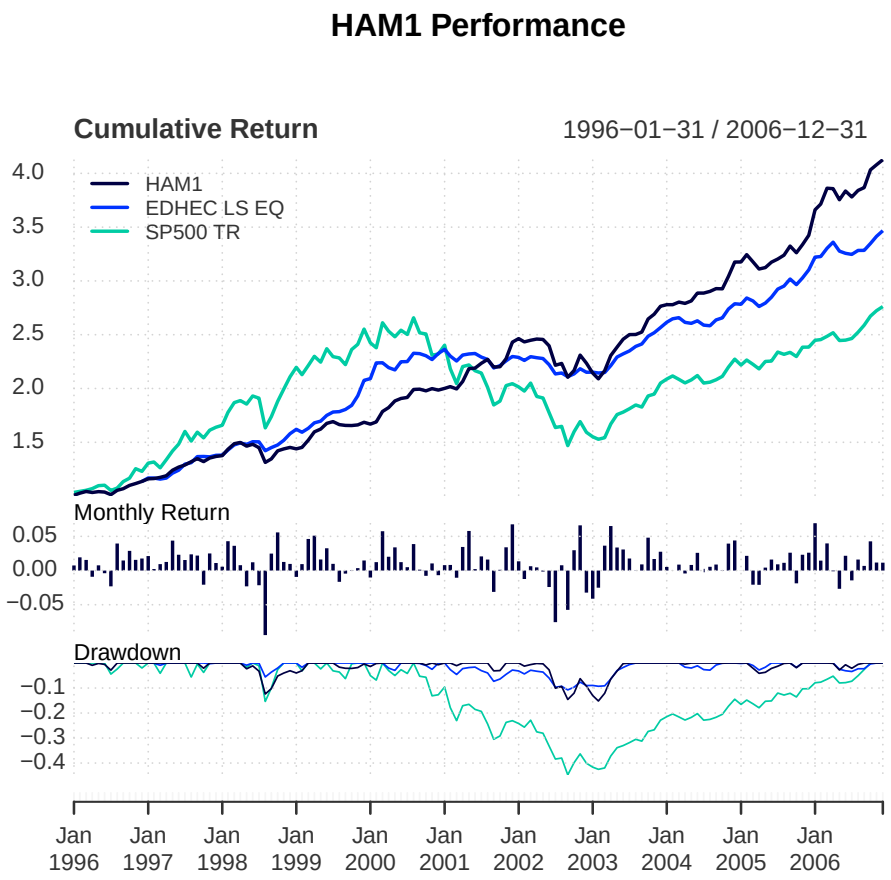
> manager.col = 1
> peers.cols = c(2,3,4,5,6)
> indexes.cols = c(7,8)
> Rf.col = 10
> #factors.cols = NA
> trailing12.rows = ((managers.length - 11):managers.length)
> trailing12.rows

 [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)
```



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	-1.1	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	-0.2	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	-7.5	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

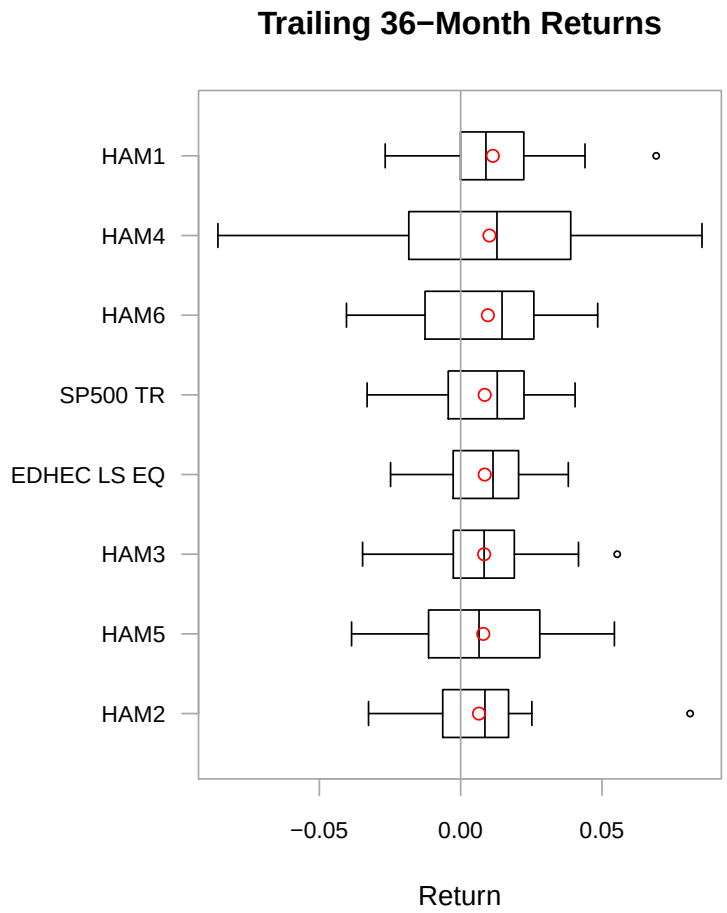
Calculate Statistics.

```
> 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

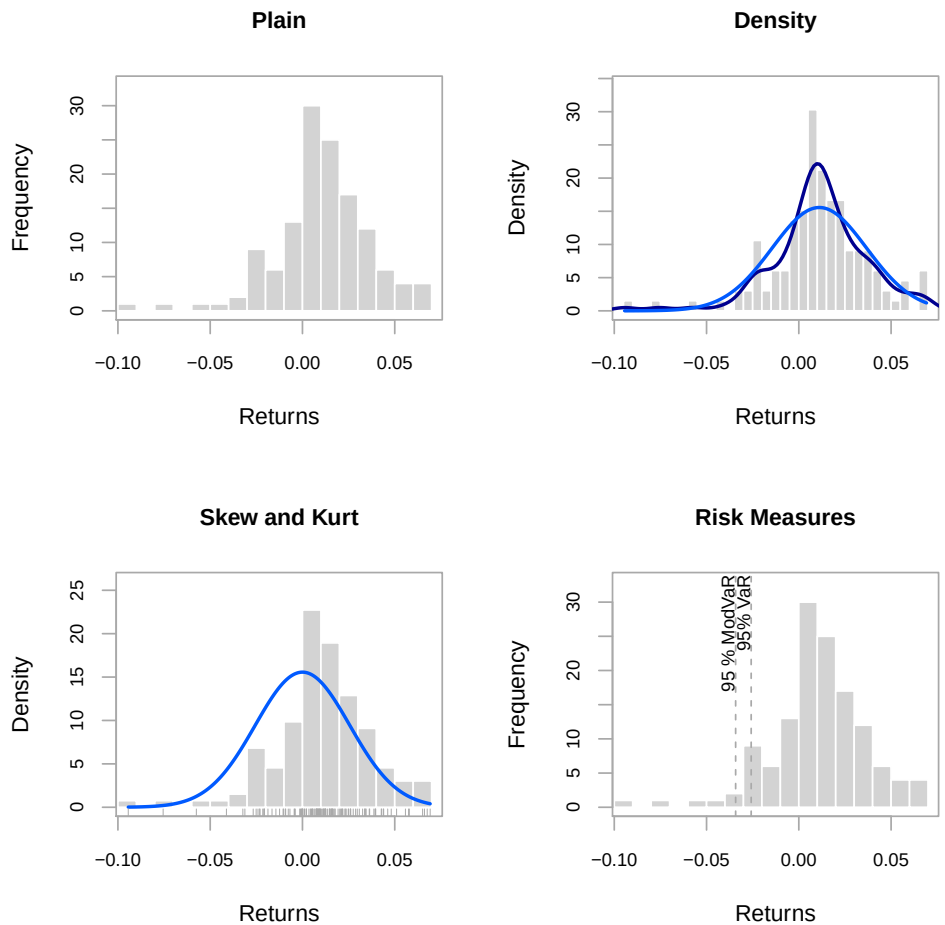
Compare Distributions.

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



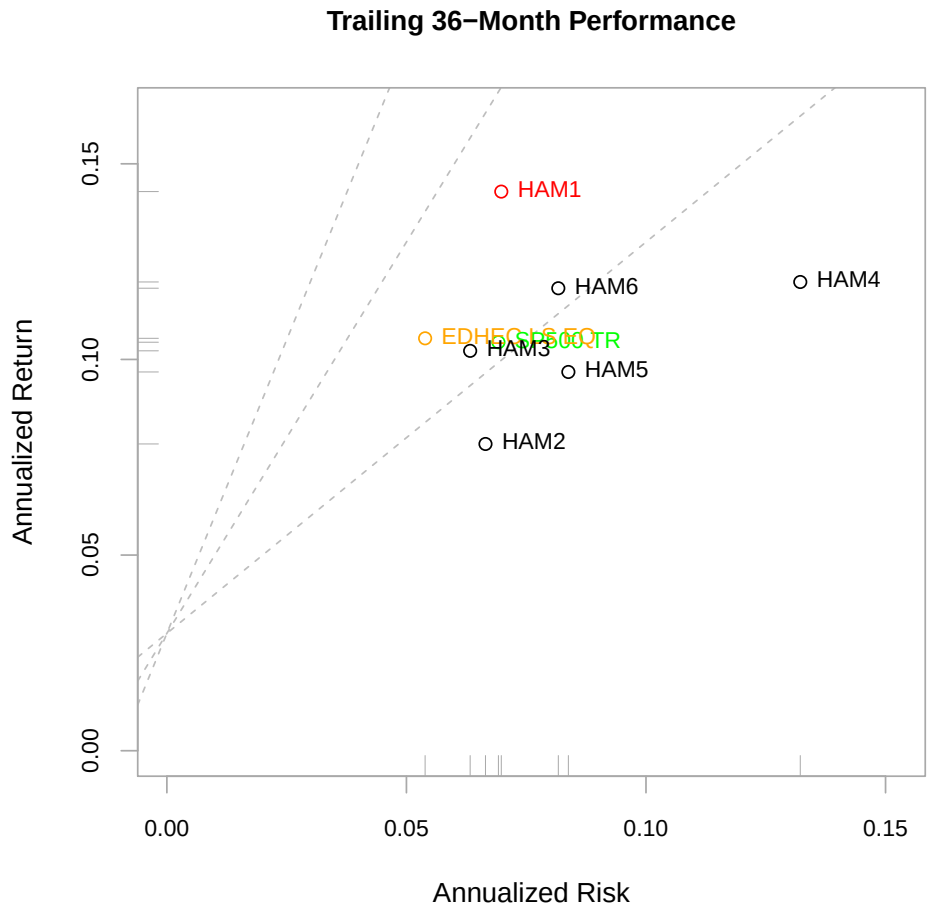
Compare Distributions.

```
> 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"))
```



Calculate Statistics.

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```

	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
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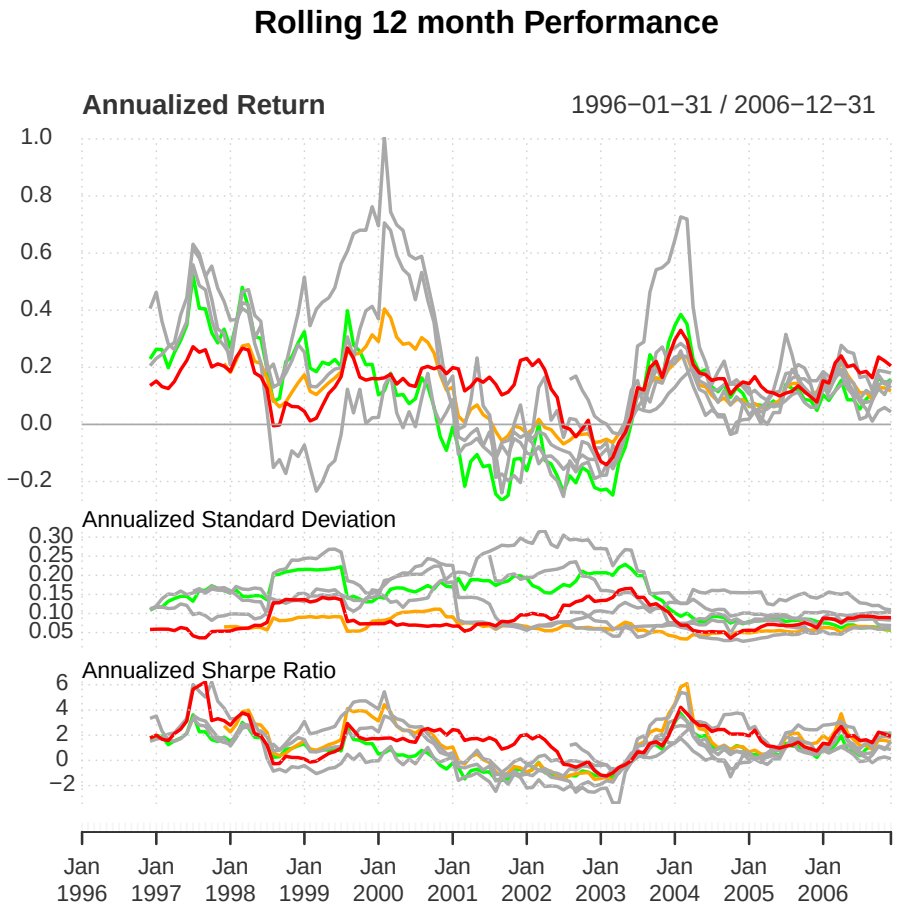
Geometric Mean	0.0108	0.0135	0.0118	0.0096	0.0031	0.0108
Quartile 3	0.0248	0.0252	0.0314	0.0460	0.0309	0.0255
Maximum	0.0692	0.1556	0.1796	0.1508	0.1747	0.0583
SE Mean	0.0022	0.0033	0.0032	0.0046	0.0052	0.0030
LCL Mean (0.95)	0.0067	0.0076	0.0062	0.0019	-0.0063	0.0051
UCL Mean (0.95)	0.0155	0.0206	0.0187	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

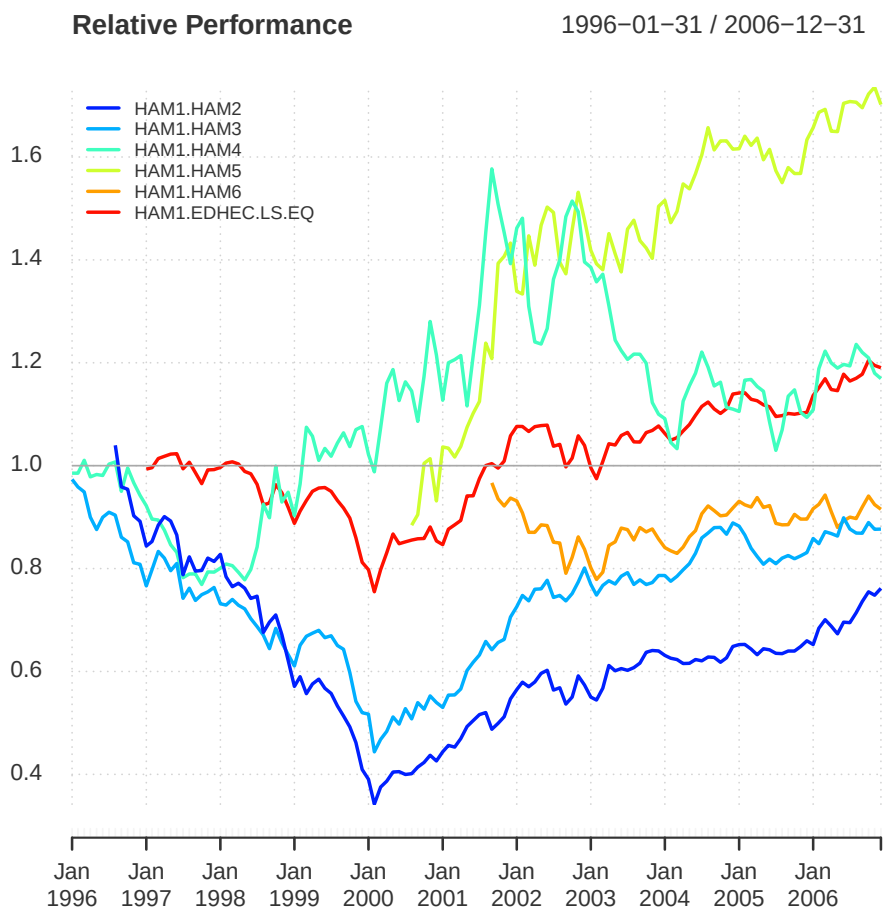
Examine Performance Consistency.

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



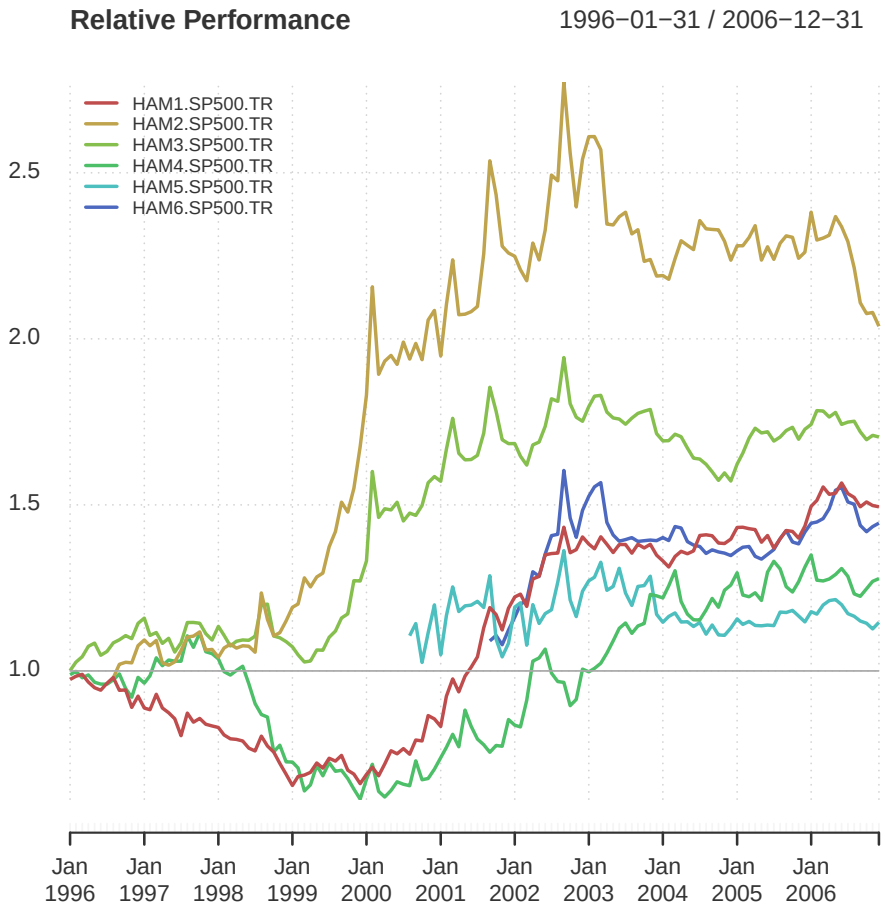
Display Relative Performance.

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

```
> 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
Beta+	0.8227	0.4176	0.8240
Beta-	1.1218	-0.0483	0.8291
R-squared	0.3829	0.1073	0.4812
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
Beta+	1.8430	1.0985	0.9993
Beta-	1.2223	0.5283	1.1320
R-squared	0.3444	0.5209	0.4757
Annualized Alpha	0.0109	0.0030	0.0271
Correlation	0.5868	0.7218	0.6897
Correlation p-value	0.0002	0.0000	0.0000
Tracking Error	0.1073	0.0583	0.0601
Active Premium	0.0154	-0.0077	0.0138
Information Ratio	0.1433	-0.1319	0.2296
Treynor Ratio	0.0768	0.0734	0.1045

table.CAPM underlying techniques

- Return.annualized — Annualized return using

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

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

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

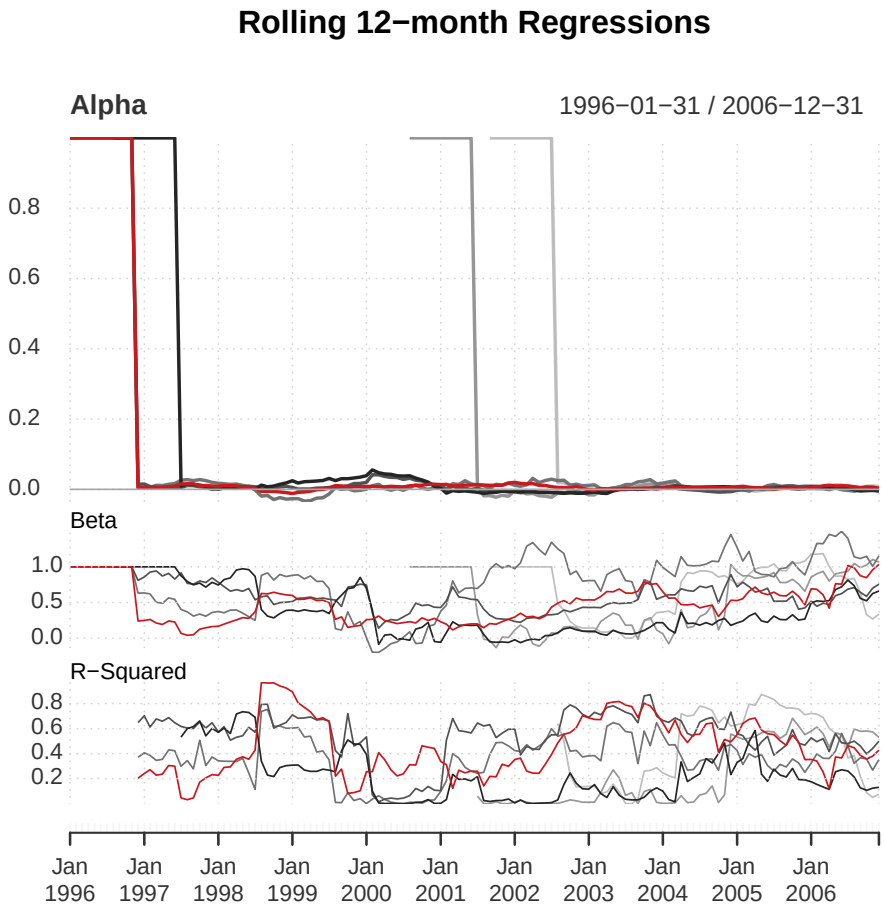
- ActivePremium — investment's annualized return minus the benchmark's annualized return
- Tracking Error — A measure of the unexplained portion of performance relative to a benchmark, given by

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

- 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)
```



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)

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

- 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

$$z_c = q_p = qnorm(p) \tag{5}$$

$$VaR = \bar{R} - z_c \cdot \sqrt{\sigma} \tag{6}$$

- 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:

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

$$modVaR = \bar{R} - z_{cf}\sqrt{\sigma} \tag{8}$$

- 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

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

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

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

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

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

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

$$\frac{(\overline{R_a - R_f})}{modVaR_{R_a,p}} \tag{12}$$

- *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 infomation 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.