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	U
Jan 1996	0.0100	NA	0.0359	0.0208	NA	NA	NA	0.0340	
Feb 1996	0.0215	NA	0.0295	0.0231	NA	NA	NA	0.0093	
Mar 1996	0.0226	NA	0.0253	-0.0053	NA	NA	NA	0.0096	
Apr 1996	0.0008	NA	0.0478	0.0200	NA	NA	NA	0.0147	
May 1996	0.0158	NA	0.0337	0.0122	NA	NA	NA	0.0258	
Jun 1996	-0.0086	NA	-0.0293	-0.0089	NA	NA	NA	0.0038	

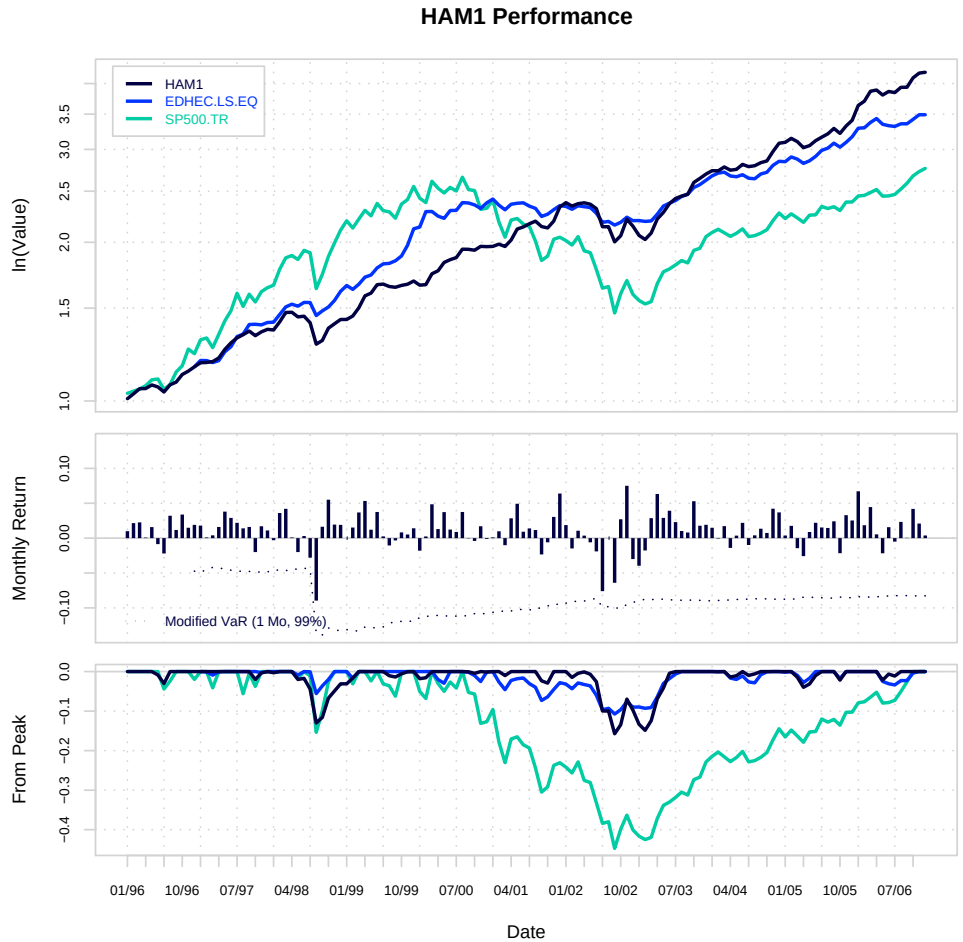
	US.3m.TR
Jan 1996	0.00456
Feb 1996	0.00398
Mar 1996	0.00371
Apr 1996	0.00428
May 1996	0.00443
Jun 1996	0.00412

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
> 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)
> 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	1.0	1.8	-0.3	0.0	-1.8	0.1	1.9	-4.0	1.5	0.4	6.7
Feb	2.1	0.1	3.6	1.5	0.2	1.0	-1.5	-1.8	-0.1	1.8	1.8
Mar	2.3	0.4	4.2	3.7	4.9	-1.0	1.1	2.9	1.7	-1.4	4.5
Apr	0.1	1.6	0.1	5.3	1.3	2.8	0.4	6.3	-1.4	-2.6	0.5
May	1.6	3.8	-2.0	1.2	3.7	4.9	-0.6	2.9	0.4	0.9	-2.2
Jun	-0.9	2.9	0.3	3.8	1.2	0.9	-1.9	3.9	2.2	2.2	1.6
Jul	-2.2	2.2	-2.8	0.2	0.9	1.4	-7.6	2.3	-1.0	1.5	-0.5
Aug	3.2	1.4	-8.9	-1.1	3.8	1.2	0.0	1.0	0.4	1.5	2.3
Sep	1.2	1.6	1.6	-0.3	0.0	-2.3	-6.4	0.8	1.4	2.4	0.0
Oct	3.4	-2.0	5.5	0.8	-0.4	-0.6	2.7	5.3	0.7	-2.2	4.2
Nov	1.5	1.7	1.9	0.5	1.7	3.0	7.5	1.8	4.2	3.3	2.1
Dec	1.9	1.1	1.9	1.4	-0.1	6.4	-3.0	1.9	3.7	2.5	0.4
HAM1	16.1	17.8	4.4	18.3	16.2	18.9	-8.1	25.5	14.4	10.5	23.3
EDHEC.LS.EQ	NA	21.4	14.6	31.4	12.0	-1.2	-6.4	19.3	8.6	11.3	10.1
SP500.TR	23.0	33.4	28.6	21.0	-9.1	-11.9	-22.1	28.7	10.9	4.9	15.8

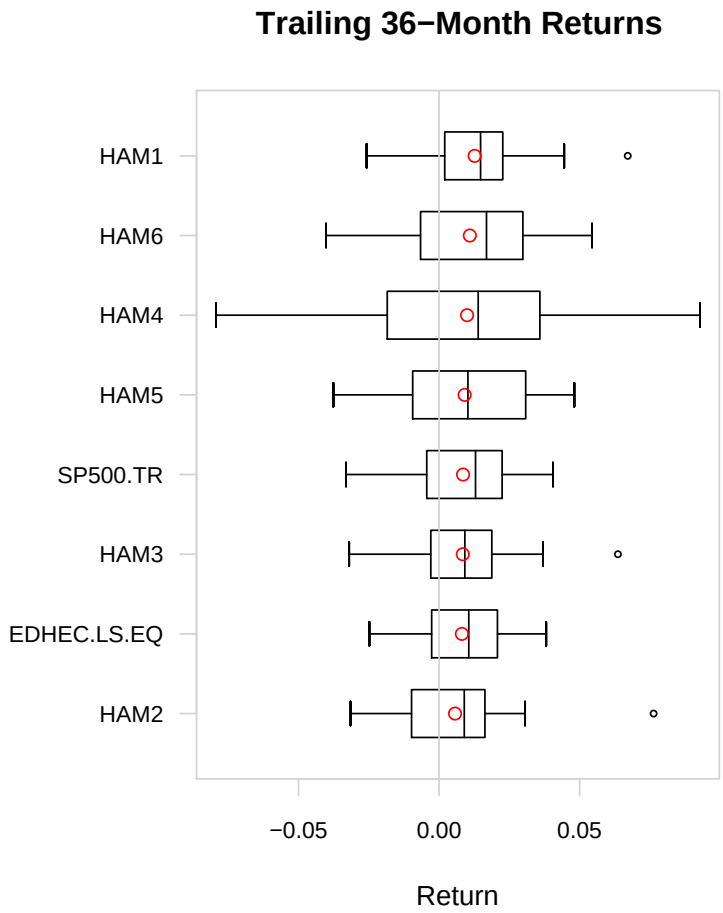
Calculate Statistics.

```
> table.MonthlyReturns(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	-0.0895	-0.0429	-0.0738	-0.1800	-0.1386	-0.0402
Quartile 1	0.0000	-0.0105	-0.0066	-0.0213	-0.0184	-0.0034
Median	0.0132	0.0060	0.0107	0.0139	0.0045	0.0146
Arithmetic Mean	0.0112	0.0138	0.0122	0.0105	0.0034	0.0121
Geometric Mean	0.0109	0.0131	0.0115	0.0091	0.0025	0.0118
Quartile 3	0.0231	0.0248	0.0312	0.0440	0.0298	0.0276
Maximum	0.0750	0.1521	0.1774	0.1583	0.1660	0.0544
SE Mean	0.0022	0.0033	0.0032	0.0047	0.0051	0.0030
LCL Mean (0.95)	0.0069	0.0072	0.0058	0.0013	-0.0067	0.0062
UCL Mean (0.95)	0.0156	0.0203	0.0186	0.0197	0.0136	0.0180
Variance	0.0006	0.0014	0.0014	0.0029	0.0020	0.0006
Stdev	0.0251	0.0369	0.0371	0.0536	0.0447	0.0238
Skewness	-0.6871	1.4564	0.8091	-0.4198	-0.0131	-0.2312
Kurtosis	2.4001	2.4099	2.3632	0.8703	2.1288	-0.5305

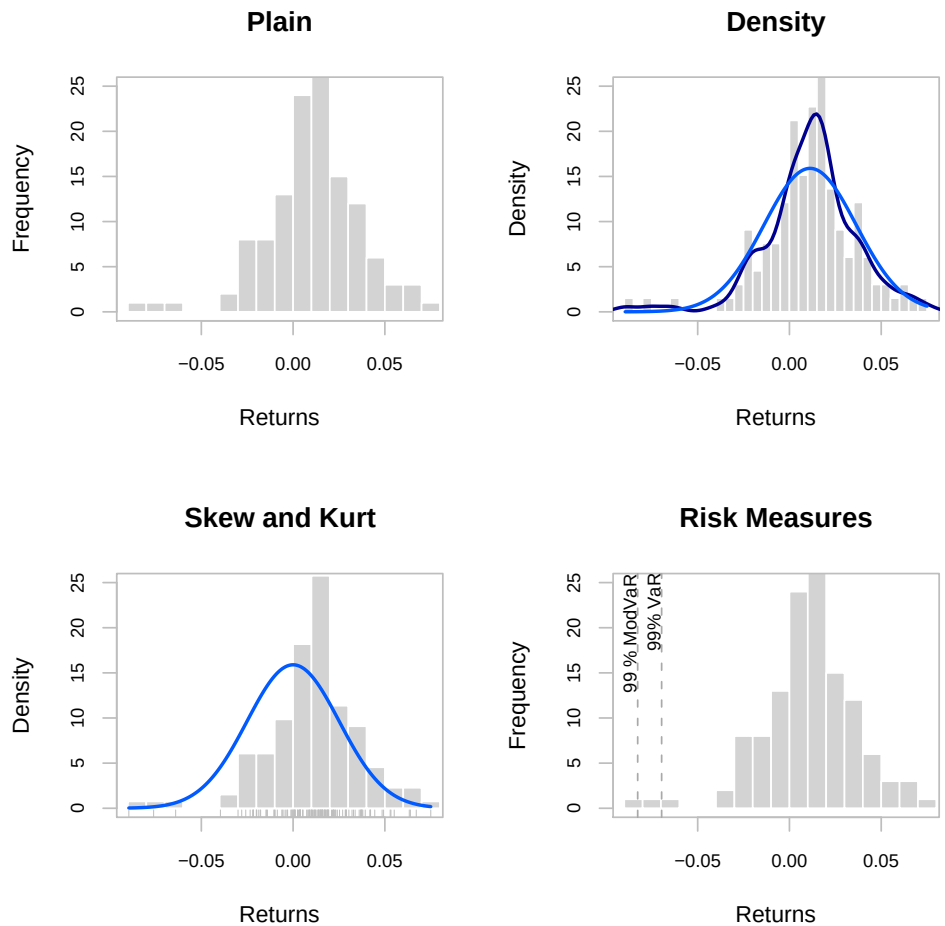
Compare Distributions.

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



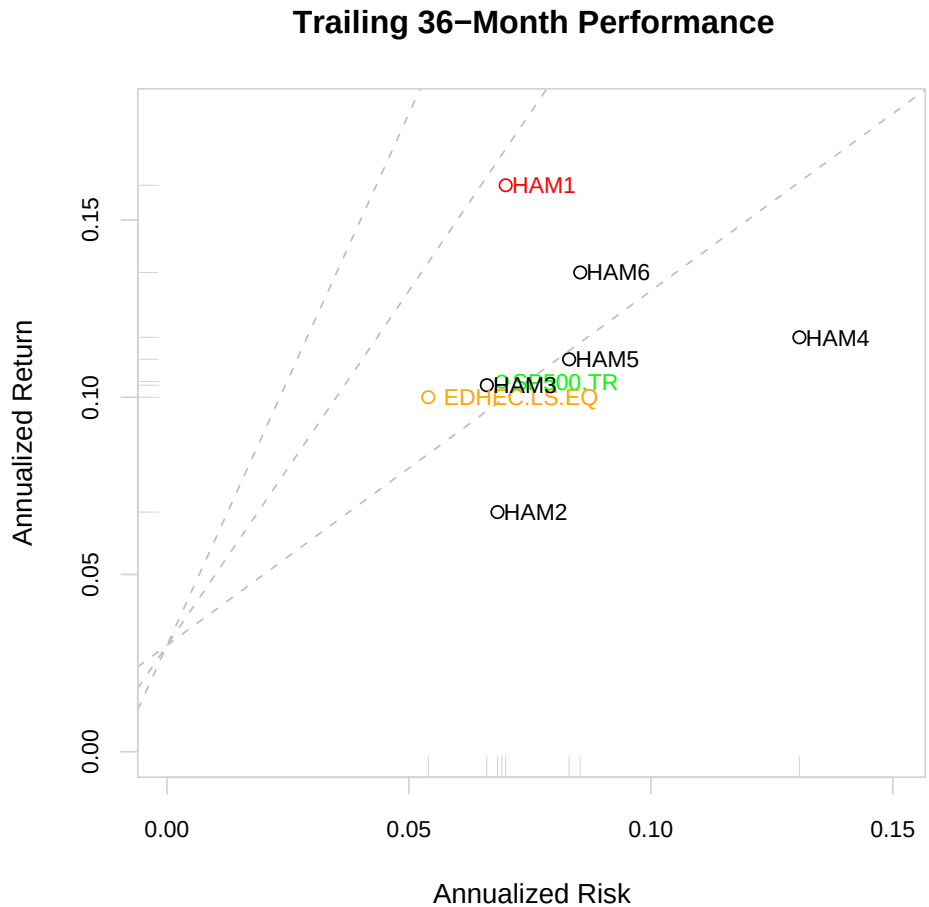
Compare Distributions.

```
> 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 = 0.03/12
+     main = "Trailing 36-Month Performance", colorset = c("red",
+         rep("black", 5), "orange", "green"))
```



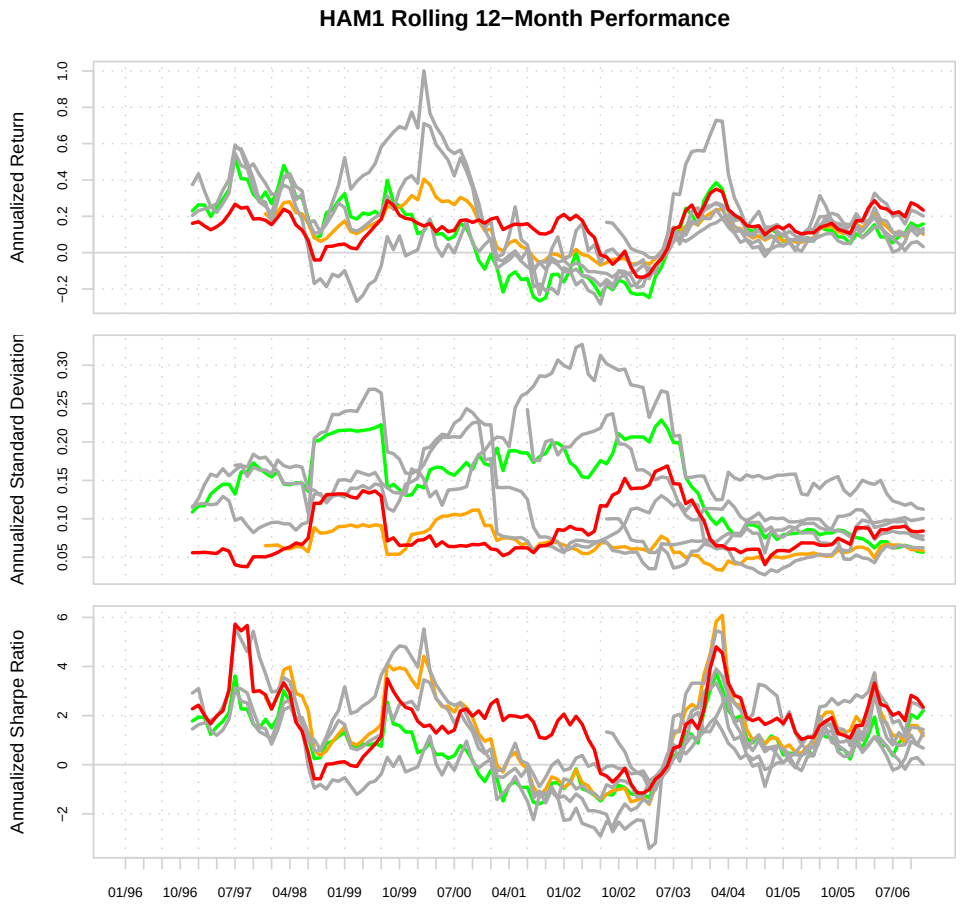
Calculate Statistics.

```
> table.MonthlyReturns(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	-0.0895	-0.0429	-0.0738	-0.1800	-0.1386	-0.0402
Quartile 1	0.0000	-0.0105	-0.0066	-0.0213	-0.0184	-0.0034
Median	0.0132	0.0060	0.0107	0.0139	0.0045	0.0146
Arithmetic Mean	0.0112	0.0138	0.0122	0.0105	0.0034	0.0121
Geometric Mean	0.0109	0.0131	0.0115	0.0091	0.0025	0.0118
Quartile 3	0.0231	0.0248	0.0312	0.0440	0.0298	0.0276
Maximum	0.0750	0.1521	0.1774	0.1583	0.1660	0.0544
SE Mean	0.0022	0.0033	0.0032	0.0047	0.0051	0.0030
LCL Mean (0.95)	0.0069	0.0072	0.0058	0.0013	-0.0067	0.0062
UCL Mean (0.95)	0.0156	0.0203	0.0186	0.0197	0.0136	0.0180
Variance	0.0006	0.0014	0.0014	0.0029	0.0020	0.0006
Stdev	0.0251	0.0369	0.0371	0.0536	0.0447	0.0238
Skewness	-0.6871	1.4564	0.8091	-0.4198	-0.0131	-0.2312
Kurtosis	2.4001	2.4099	2.3632	0.8703	2.1288	-0.5305

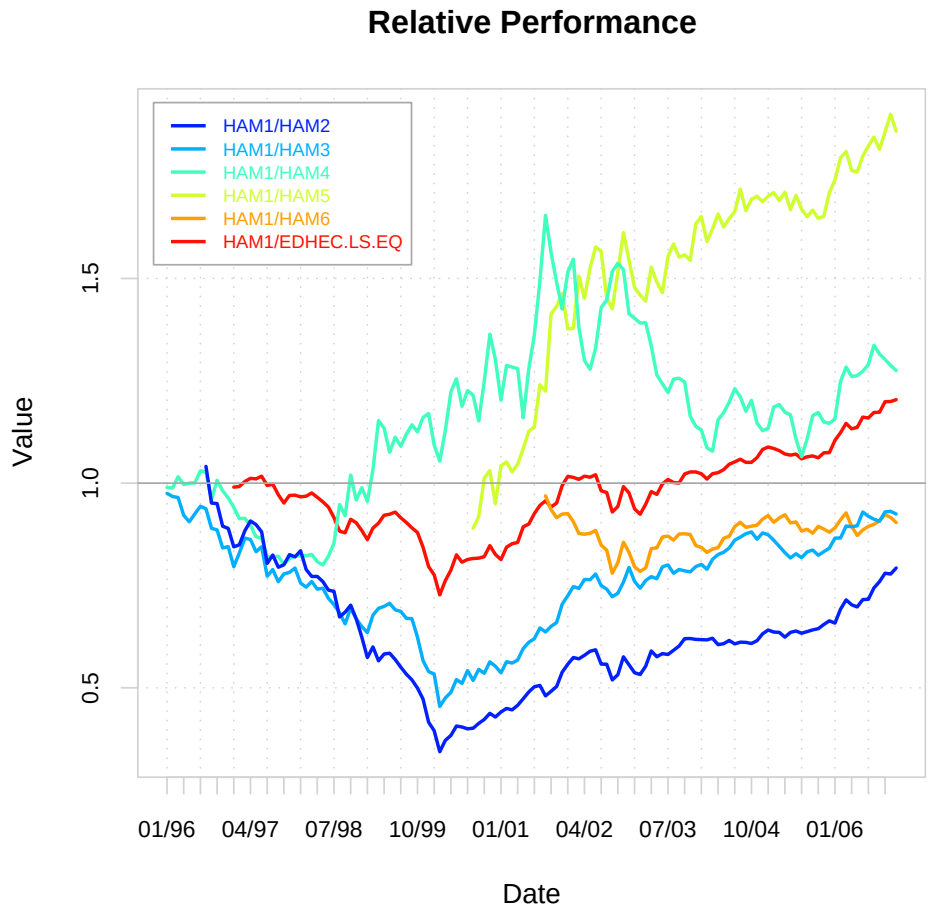
Examine Performance Consistency.

```
> charts.RollingPerformance(managers[, c(manager.col, peers.cols,
+     indexes.cols)], rf = 0.03/12, colorset = c("red", rep("darkgray"
+     5), "orange", "green"), lwd = 2)
```



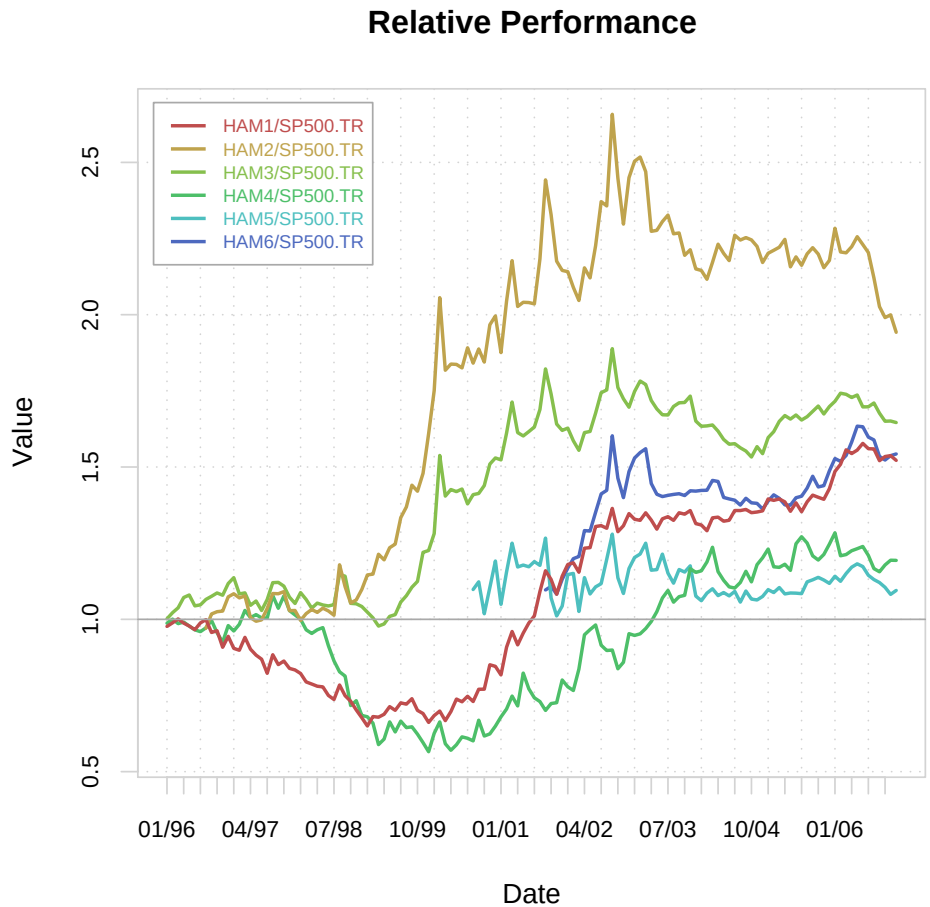
Display Relative Performance.

```
> chart.RelativePerformance(managers[, manager.col, drop = FALSE],
+     managers[, c(peers.cols, 7)], colorset = tim8equal[-1], lwd = 2,
+     legend.loc = "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, 8, drop = FALSE], rf = managers[trailing36.rows,
+         Rf.col, drop = F])
```

	HAM1 to SP500.TR	HAM2 to SP500.TR	HAM3 to SP500.TR
Alpha	0.0061	0.0006	0.0015
Beta	0.6713	0.4178	0.7349
R-squared	0.4397	0.1715	0.5907
Annualized Alpha	0.0755	0.0076	0.0180
Correlation	0.6631	0.4142	0.7686
Correlation p-value	0.0000	0.0120	0.0000
Tracking Error	0.0868	0.0601	0.0021
Active Premium	0.0538	-0.0359	-0.0010
Information Ratio	0.6201	-0.5974	-0.4973
Treynor Ratio	0.1870	0.0857	0.0962
	HAM4 to SP500.TR	HAM5 to SP500.TR	HAM6 to SP500.TR
Alpha	0.0005	0.0015	0.0033
Beta	1.1570	0.8442	0.8574
R-squared	0.3697	0.4887	0.4830
Annualized Alpha	0.0059	0.0181	0.0399
Correlation	0.6080	0.6991	0.6950
Correlation p-value	0.0001	0.0000	0.0000
Tracking Error	0.0302	0.0119	0.0508
Active Premium	0.0120	0.0061	0.0299
Information Ratio	0.3984	0.5148	0.5889
Treynor Ratio	0.0724	0.0922	0.1186

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

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

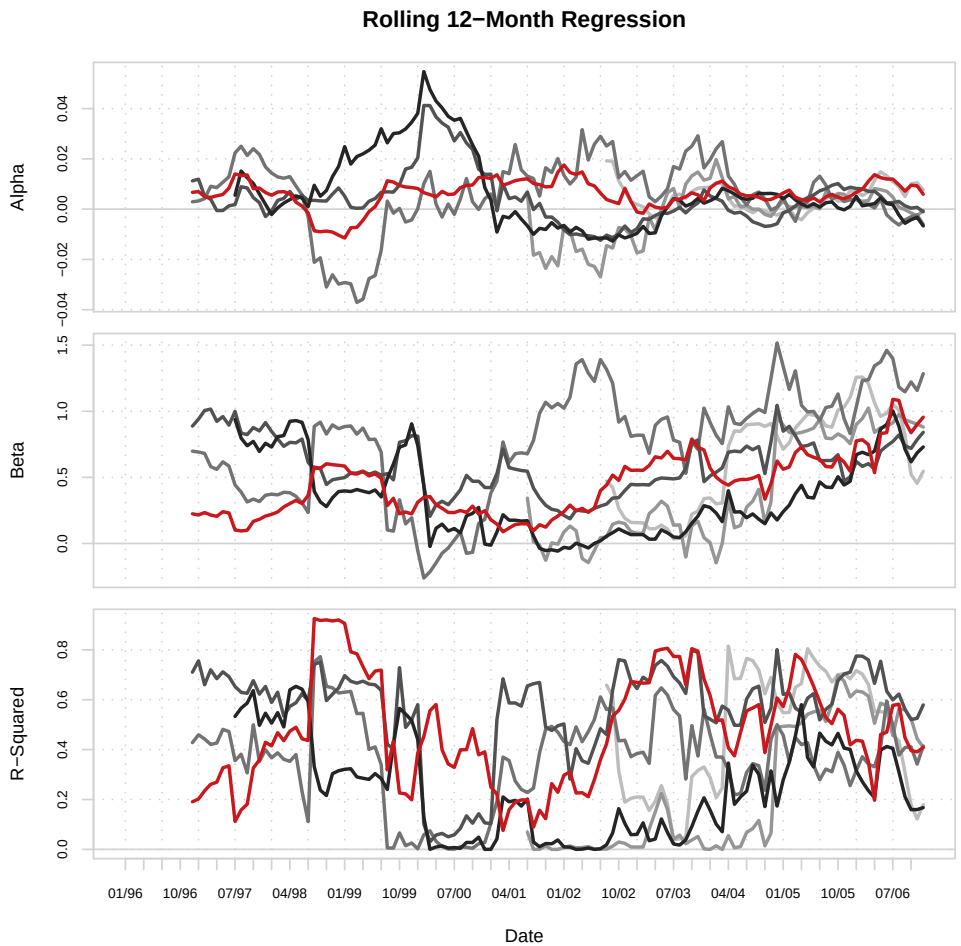
- ActivePremium — investment's annualized return minus the benchmark's annualized return
- Tracking Error — A measure of the unexplained portion of performance relative to a benchmark, given by

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

- InformationRatio — ActivePremium/TrackingError

Compare to a Benchmark.

```
> charts.RollingRegression(managers[, c(manager.col, peers.cols),
+     drop = FALSE], managers[, 8, drop = FALSE], rf = 0.03/12,
+     colorset = redfocus, lwd = 2)
```



Calculate Downside Risk.

```
> table.DownsideRisk(managers[, 1:6], rf = 0.03/12)
```

	HAM1	HAM2	HAM3	HAM4	HAM5	
Semi Deviation	0.0188	0.0203	0.0239	0.0397	0.0320	
Gain Deviation	0.0164	0.0347	0.0296	0.0314	0.0298	
Loss Deviation	0.0209	0.0099	0.0187	0.0371	0.0321	
Downside Deviation (MAR=10%)	0.0175	0.0168	0.0218	0.0386	0.0346	
Downside Deviation (rf=3%)	0.0151	0.0133	0.0188	0.0357	0.0316	
Downside Deviation (0%)	0.0142	0.0119	0.0176	0.0345	0.0303	
Maximum Drawdown	-0.1573	-0.2240	-0.2786	-0.2913	-0.3775	-
VaR (99%)	0.0696	0.0996	0.0985	0.1352	0.1075	
Beyond VaR	0.0704	0.1010	0.0997	0.1366	0.1078	
Modified VaR (99%)	0.0827	0.0804	0.0788	0.1282	0.0989	

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.

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Management & Technology Consultants