Exploratory Data Analysis in Finance Using PerformanceAnalytics

Brian G. Peterson & Peter Carl

1Diamond Management & Technology Consultants
   Chicago, IL
   brian@braverock.com

2Guidance Capital
   Chicago, IL
   peter@braverock.com

UseR! International User and Developer Conference, Ames, Iowa,
8-10 Aug 2007
Outline

Visualization

Methods

Summary

Appendix: Set Up PerformanceAnalytics
Overview

- Exploratory data analysis with finance data often starts with visual examination to:
  - examine properties of asset returns
  - compare an asset to other similar assets
  - compare an asset to one or more benchmarks
- Application of performance and risk measures can build a set of statistics for comparing possible investments
- Examples are developed using data for six (hypothetical) managers, a peer index, and an asset class index
- Hypothetical manager data was developed from real manager timeseries using *accuracy* and *perturb* packages to disguise the data while maintaining some of the statistical properties of the original data.
Draw a Performance Summary Chart.

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

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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>0.7</td>
<td>2.1</td>
<td>0.6</td>
<td>-0.9</td>
<td>-1.0</td>
<td>0.8</td>
<td>-4.1</td>
<td>0.5</td>
<td>0.0</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>1.9</td>
<td>0.2</td>
<td>4.3</td>
<td>0.9</td>
<td>1.2</td>
<td>0.8</td>
<td>-1.2</td>
<td>-2.5</td>
<td>0.0</td>
<td>2.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Mar</td>
<td>1.6</td>
<td>0.9</td>
<td>3.6</td>
<td>4.6</td>
<td>5.8</td>
<td>-1.1</td>
<td>0.6</td>
<td>3.6</td>
<td>0.9</td>
<td>-2.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Apr</td>
<td>-0.9</td>
<td>1.3</td>
<td>0.8</td>
<td>5.1</td>
<td>2.0</td>
<td>3.5</td>
<td>0.5</td>
<td>6.5</td>
<td>-0.4</td>
<td>-2.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>May</td>
<td>0.8</td>
<td>4.4</td>
<td>-2.3</td>
<td>1.6</td>
<td>3.4</td>
<td>5.8</td>
<td>-0.2</td>
<td>3.4</td>
<td>0.8</td>
<td>0.4</td>
<td>-2.7</td>
</tr>
<tr>
<td>Jun</td>
<td>-0.4</td>
<td>2.3</td>
<td>1.2</td>
<td>3.3</td>
<td>1.2</td>
<td>0.2</td>
<td>-2.4</td>
<td>3.1</td>
<td>2.6</td>
<td>1.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Jul</td>
<td>-2.3</td>
<td>1.5</td>
<td>-2.1</td>
<td>1.0</td>
<td>0.5</td>
<td>2.1</td>
<td>-7.5</td>
<td>1.8</td>
<td>0.0</td>
<td>0.9</td>
<td>-1.4</td>
</tr>
<tr>
<td>Aug</td>
<td>4.0</td>
<td>2.4</td>
<td>-9.4</td>
<td>-1.7</td>
<td>3.9</td>
<td>1.6</td>
<td>0.8</td>
<td>0.0</td>
<td>0.5</td>
<td>1.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Sep</td>
<td>1.5</td>
<td>2.2</td>
<td>2.5</td>
<td>-0.4</td>
<td>0.1</td>
<td>-3.1</td>
<td>-5.8</td>
<td>0.9</td>
<td>0.9</td>
<td>2.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Oct</td>
<td>2.9</td>
<td>-2.1</td>
<td>5.6</td>
<td>-0.1</td>
<td>-0.8</td>
<td>0.1</td>
<td>3.0</td>
<td>4.8</td>
<td>-0.1</td>
<td>-1.9</td>
<td>4.3</td>
</tr>
<tr>
<td>Nov</td>
<td>1.6</td>
<td>2.5</td>
<td>1.3</td>
<td>0.4</td>
<td>1.0</td>
<td>3.4</td>
<td>6.6</td>
<td>1.7</td>
<td>3.9</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Dec</td>
<td>1.8</td>
<td>1.1</td>
<td>1.0</td>
<td>1.5</td>
<td>-0.7</td>
<td>6.8</td>
<td>-3.2</td>
<td>2.8</td>
<td>4.4</td>
<td>2.6</td>
<td>1.1</td>
</tr>
<tr>
<td>HAM1</td>
<td>13.6</td>
<td>20.4</td>
<td>6.1</td>
<td>16.1</td>
<td>17.7</td>
<td>22.4</td>
<td>-8.0</td>
<td>23.7</td>
<td>14.9</td>
<td>7.8</td>
<td>20.5</td>
</tr>
<tr>
<td>EDHEC LS EQ NA</td>
<td>21.4</td>
<td>14.6</td>
<td>31.4</td>
<td>12.0</td>
<td>-1.2</td>
<td>-6.4</td>
<td>19.3</td>
<td>8.6</td>
<td>11.3</td>
<td>11.7</td>
<td></td>
</tr>
<tr>
<td>SP500 TR</td>
<td>23.0</td>
<td>33.4</td>
<td>28.6</td>
<td>21.0</td>
<td>-9.1</td>
<td>-11.9</td>
<td>-22.1</td>
<td>28.7</td>
<td>10.9</td>
<td>4.9</td>
<td>15.8</td>
</tr>
</tbody>
</table>
Calculate Statistics.

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

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

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

![Boxplot of Trailing 36-Month Returns](image)
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, main = 
+ "Trailing 36-Month Performance", colorset=c("red", rep("black",5), "orange",
+ "green"))
```

![Trailing 36-Month Performance](image)
Examine Performance Consistency.

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

```r
> chart.RelativePerformance(managers[, manager.col, drop = FALSE],
+ managers[, c(peers.cols, 7)], colorset = tim8equal[-1], lwd = 2, legend.loc
+ = "topleft")
```
Compare to a Benchmark.

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

![Relative Performance Chart](image)
Compare to a Benchmark.

```r
> table.CAPM(managers[trailing36.rows, c(manager.col, peers.cols)],
+ managers[ trailing36.rows, 8, drop=FALSE], Rf = managers[ trailing36.rows,
+ Rf.col, drop=F ])

<table>
<thead>
<tr>
<th></th>
<th>HAM1 to SP500 TR</th>
<th>HAM2 to SP500 TR</th>
<th>HAM3 to SP500 TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>0.0051</td>
<td>0.0020</td>
<td>0.0020</td>
</tr>
<tr>
<td>Beta</td>
<td>0.6267</td>
<td>0.3223</td>
<td>0.6320</td>
</tr>
<tr>
<td>Beta+</td>
<td>0.8227</td>
<td>0.4176</td>
<td>0.8240</td>
</tr>
<tr>
<td>Beta-</td>
<td>1.1218</td>
<td>-0.0483</td>
<td>0.8291</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.3829</td>
<td>0.1073</td>
<td>0.4812</td>
</tr>
<tr>
<td>Annualized Alpha</td>
<td>0.0631</td>
<td>0.0247</td>
<td>0.0243</td>
</tr>
<tr>
<td>Correlation</td>
<td>0.6188</td>
<td>0.3276</td>
<td>0.6937</td>
</tr>
<tr>
<td>Correlation p-value</td>
<td>0.0001</td>
<td>0.0511</td>
<td>0.0000</td>
</tr>
<tr>
<td>Tracking Error</td>
<td>0.0604</td>
<td>0.0790</td>
<td>0.0517</td>
</tr>
<tr>
<td>Active Premium</td>
<td>0.0384</td>
<td>-0.0260</td>
<td>-0.0022</td>
</tr>
<tr>
<td>Information Ratio</td>
<td>0.6363</td>
<td>-0.3295</td>
<td>-0.0428</td>
</tr>
<tr>
<td>Treynor Ratio</td>
<td>0.1741</td>
<td>0.1437</td>
<td>0.1101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>HAM4 to SP500 TR</th>
<th>HAM5 to SP500 TR</th>
<th>HAM6 to SP500 TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>0.0009</td>
<td>0.0002</td>
<td>0.0022</td>
</tr>
<tr>
<td>Beta</td>
<td>1.1282</td>
<td>0.8755</td>
<td>0.8150</td>
</tr>
<tr>
<td>Beta+</td>
<td>1.8430</td>
<td>1.0985</td>
<td>0.9993</td>
</tr>
<tr>
<td>Beta-</td>
<td>1.2223</td>
<td>0.5283</td>
<td>1.1320</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.3444</td>
<td>0.5209</td>
<td>0.4757</td>
</tr>
<tr>
<td>Annualized Alpha</td>
<td>0.0109</td>
<td>0.0030</td>
<td>0.0271</td>
</tr>
<tr>
<td>Correlation</td>
<td>0.5868</td>
<td>0.7218</td>
<td>0.6897</td>
</tr>
<tr>
<td>Correlation p-value</td>
<td>0.0002</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Tracking Error</td>
<td>0.1073</td>
<td>0.0583</td>
<td>0.0601</td>
</tr>
<tr>
<td>Active Premium</td>
<td>0.0154</td>
<td>-0.0077</td>
<td>0.0138</td>
</tr>
<tr>
<td>Information Ratio</td>
<td>0.1433</td>
<td>-0.1319</td>
<td>0.2296</td>
</tr>
<tr>
<td>Treynor Ratio</td>
<td>0.0768</td>
<td>0.0734</td>
<td>0.1045</td>
</tr>
</tbody>
</table>
```
Calculate Returns.

- The single-period arithmetic return, or simple return, can be calculated as

\[ R_t = \frac{P_t}{P_{t-1}} - 1 = \frac{P_t - P_{t-1}}{P_{t-1}} \]  \hspace{1cm} (1)

- Simple returns, cannot be added together. A multiple-period simple return is calculated as:

\[ R_t = \frac{P_t}{P_{t-k}} - 1 = \frac{P_t - P_{t-k}}{P_{t-k}} \]  \hspace{1cm} (2)

- The natural logarithm of the simple return of an asset is referred to as the continuously compounded return, or log return:

\[ r_t = \ln(1 + R_t) = \ln \left(\frac{P_t}{P_{t-1}}\right) = p_t - p_{t-1} \]  \hspace{1cm} (3)

- Calculating log returns from simple gross return, or vice versa:

\[ r_t = \ln(1 + R_t), \quad R_t = \exp(r_t) - 1. \]  \hspace{1cm} (4)

- `Return.calculate` or `CalculateReturns` (now deprecated) may be used to compute discrete and continuously compounded returns for data containing asset prices.
CAPM underlying techniques

- **Return.annualized** — Annualized return using

  \[
  \prod(1 + R_a)^{\frac{\text{scale}}{n}} - 1 = \sqrt[n]{\prod(1 + R_a)^{\text{scale}}} - 1
  \]  
  \(5\)

- **TreynorRatio** — ratio of asset’s Excess Return to Beta \(\beta\) of the benchmark

  \[
  \frac{(R_a - R_f)}{\beta_{a,b}}
  \]  
  \(6\)

- **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

  \[
  \text{TrackingError} = \sqrt{\sum \frac{(R_a - R_b)^2}{\text{len}(R_a) \sqrt{\text{scale}}}}
  \]  
  \(7\)

- **InformationRatio** — ActivePremium/TrackingError
Compare to a Benchmark.

```r
> charts.RollingRegression(managers[, c(manager.col, peers.cols), drop = + FALSE], managers[, 8, drop = FALSE], Rf = .03/12, colorset = redfocus, lwd = + 2)
```

**Rolling 12-month Regressions**

- **Alpha**
- **Beta**
- **R-Squared**
Calculate Downside Risk.

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

<table>
<thead>
<tr>
<th></th>
<th>HAM1</th>
<th>HAM2</th>
<th>HAM3</th>
<th>HAM4</th>
<th>HAM5</th>
<th>HAM6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi Deviation</td>
<td>0.0191</td>
<td>0.0201</td>
<td>0.0237</td>
<td>0.0395</td>
<td>0.0324</td>
<td>0.0175</td>
</tr>
<tr>
<td>Gain Deviation</td>
<td>0.0169</td>
<td>0.0347</td>
<td>0.0290</td>
<td>0.0311</td>
<td>0.0313</td>
<td>0.0149</td>
</tr>
<tr>
<td>Loss Deviation</td>
<td>0.0211</td>
<td>0.0107</td>
<td>0.0191</td>
<td>0.0365</td>
<td>0.0324</td>
<td>0.0128</td>
</tr>
<tr>
<td>Downside Deviation (MAR=10%)</td>
<td>0.0178</td>
<td>0.0164</td>
<td>0.0214</td>
<td>0.0381</td>
<td>0.0347</td>
<td>0.0161</td>
</tr>
<tr>
<td>Downside Deviation (Rf=3%)</td>
<td>0.0154</td>
<td>0.0129</td>
<td>0.0185</td>
<td>0.0353</td>
<td>0.0316</td>
<td>0.0133</td>
</tr>
<tr>
<td>Downside Deviation (0%)</td>
<td>0.0145</td>
<td>0.0116</td>
<td>0.0174</td>
<td>0.0341</td>
<td>0.0304</td>
<td>0.0121</td>
</tr>
<tr>
<td>Maximum Drawdown</td>
<td>0.1518</td>
<td>0.2399</td>
<td>0.2894</td>
<td>0.2874</td>
<td>0.3405</td>
<td>0.0788</td>
</tr>
<tr>
<td>Historical VaR (95%)</td>
<td>-0.0258</td>
<td>-0.0294</td>
<td>-0.0425</td>
<td>-0.0799</td>
<td>-0.0733</td>
<td>-0.0341</td>
</tr>
<tr>
<td>Historical ES (95%)</td>
<td>-0.0513</td>
<td>-0.0331</td>
<td>-0.0555</td>
<td>-0.1122</td>
<td>-0.1023</td>
<td>-0.0392</td>
</tr>
<tr>
<td>Modified VaR (95%)</td>
<td>-0.0342</td>
<td>-0.0276</td>
<td>-0.0368</td>
<td>-0.0815</td>
<td>-0.0676</td>
<td>-0.0298</td>
</tr>
<tr>
<td>Modified ES (95%)</td>
<td>-0.0610</td>
<td>-0.0614</td>
<td>-0.0440</td>
<td>-0.1176</td>
<td>-0.0974</td>
<td>-0.0390</td>
</tr>
</tbody>
</table>
Semivariance and Downside Deviation

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

\[ \delta_{MAR} = \sqrt{\frac{\sum_{t=1}^{n} (R_t - MAR)^2}{n}} \] (8)

▶ 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

\[
    z_c = q_p = qnorm(p) \tag{9}
\]

\[
    \text{VaR} = \bar{R} - z_c \cdot \sqrt{\sigma} \tag{10}
\]

- 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:

\[
    z_{cf} = z_c + \frac{(z_c^2 - 1)S}{6} + \frac{(z_c^3 - 3z_c)K}{24} + \frac{(2z_c^3 - 5z_c)S^2}{36} \tag{11}
\]

\[
    \text{modVaR} = \bar{R} - z_{cf} \sqrt{\sigma} \tag{12}
\]

- 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

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

  \(13\)

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

  \[
  \frac{(R_a - MAR)}{\delta_{MAR}}
  \]

  \(14\)

- **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

  \[
  \frac{\sum_{t=1}^{n} (R_t - MAR)}{\delta_{MAR}}
  \]

  \(15\)

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

  \[
  \frac{(R_a - R_f)}{modVaR_{R_a, p}}
  \]

  \(16\)
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.
- *PerformanceAnalytics* contains several tools for measuring and visualizing data that may be used 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.
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.

```r
> 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.

```r
> 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)
> trailing36.rows
> trailing60.rows = ((managers.length - 59):managers.length)
> #assume contiguous NAs - this may not be the way to do it na.contiguous()?
> 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

Cumulative Return

Monthly Return

Drawdown