Characterizing Hedge Fund Clustering

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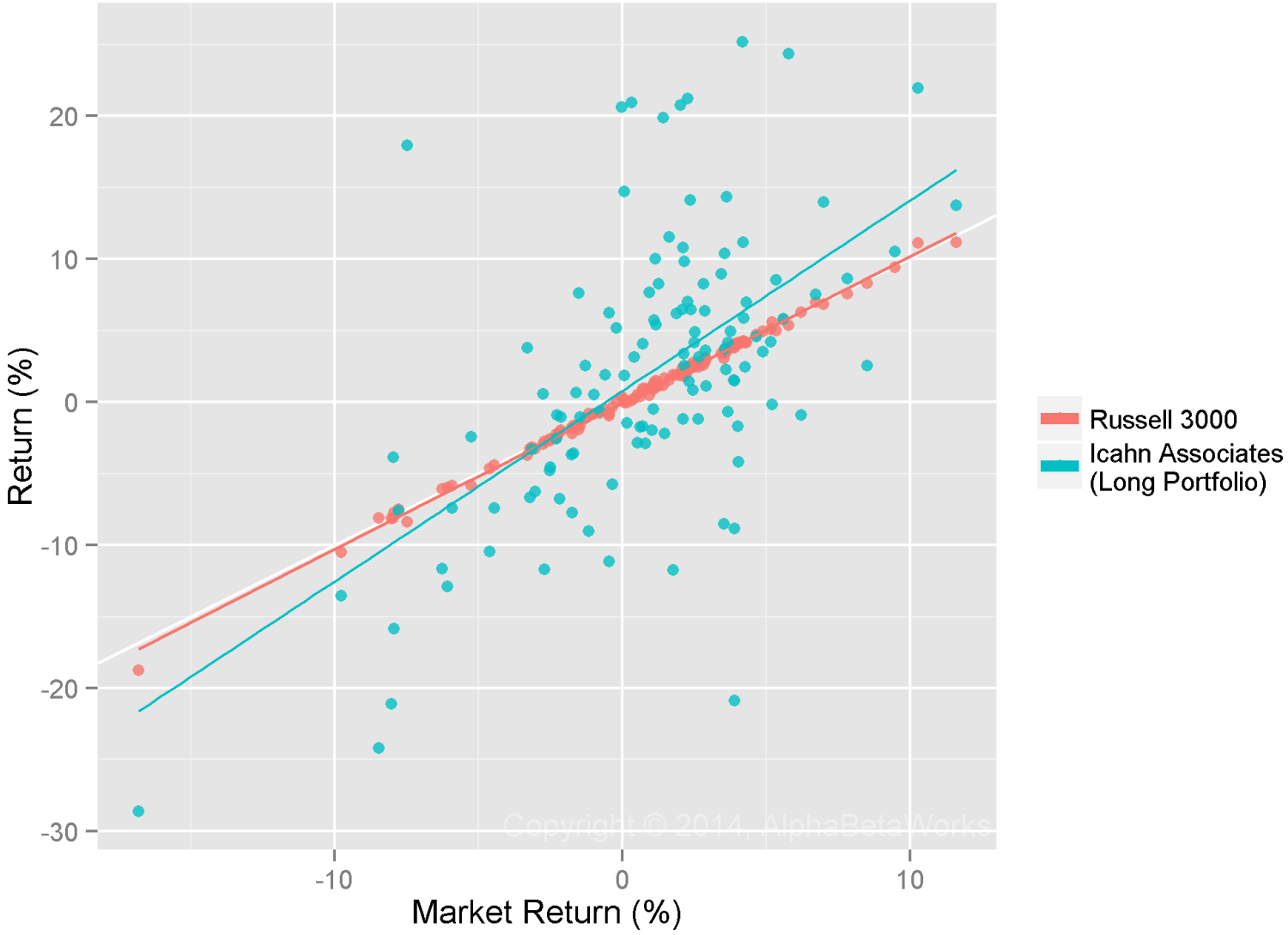
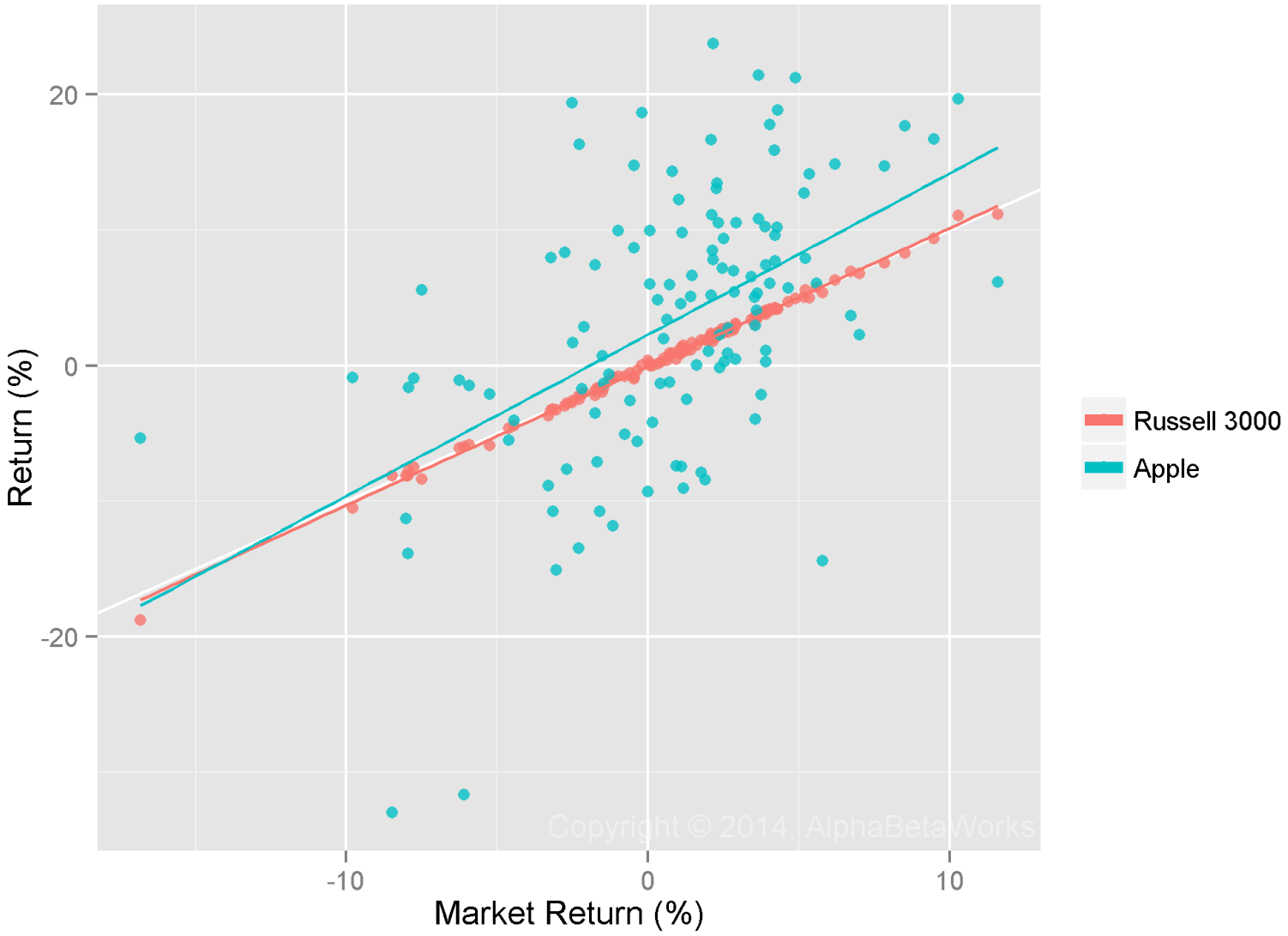
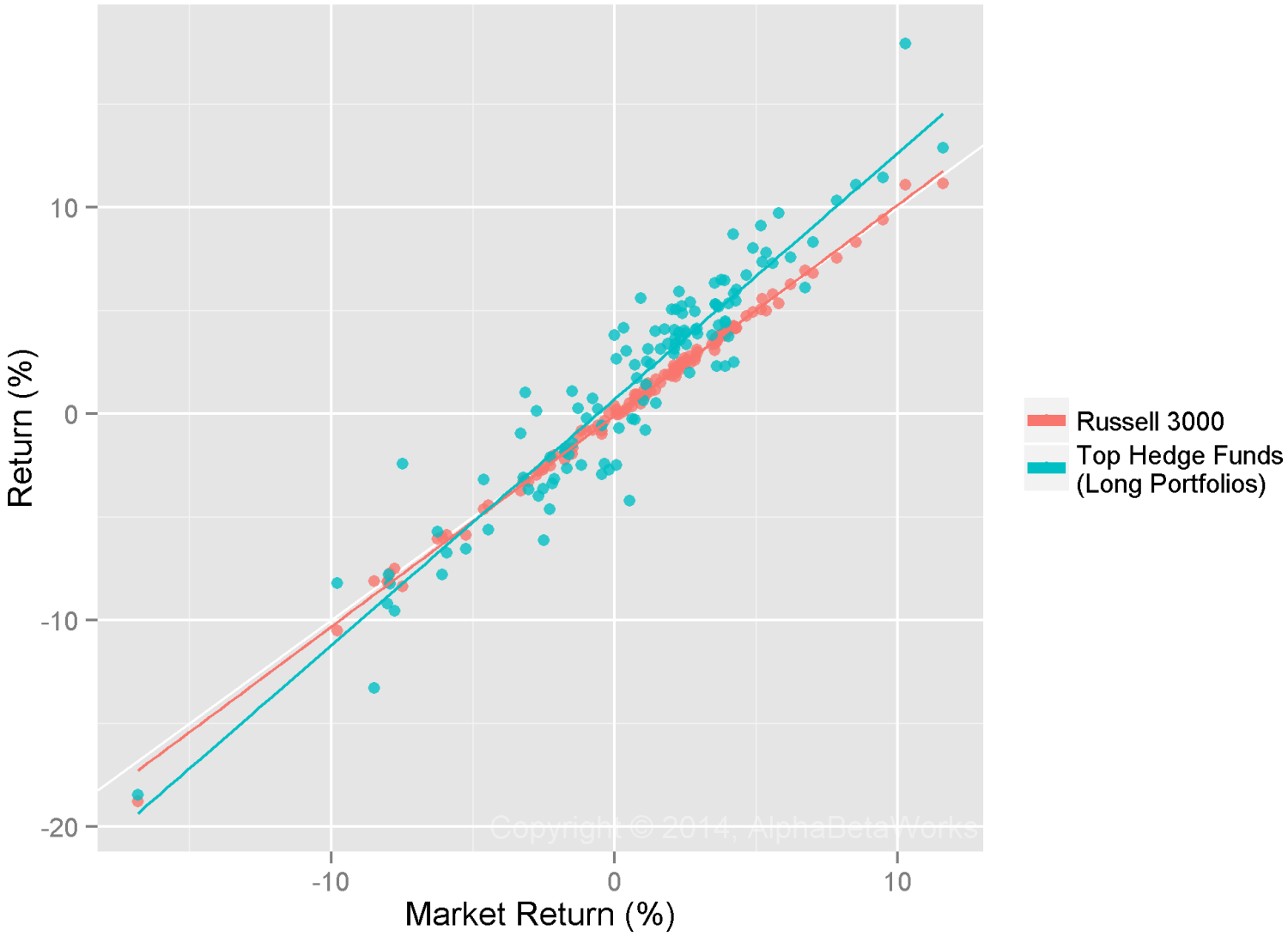
Why do Hedge Funds Exist?



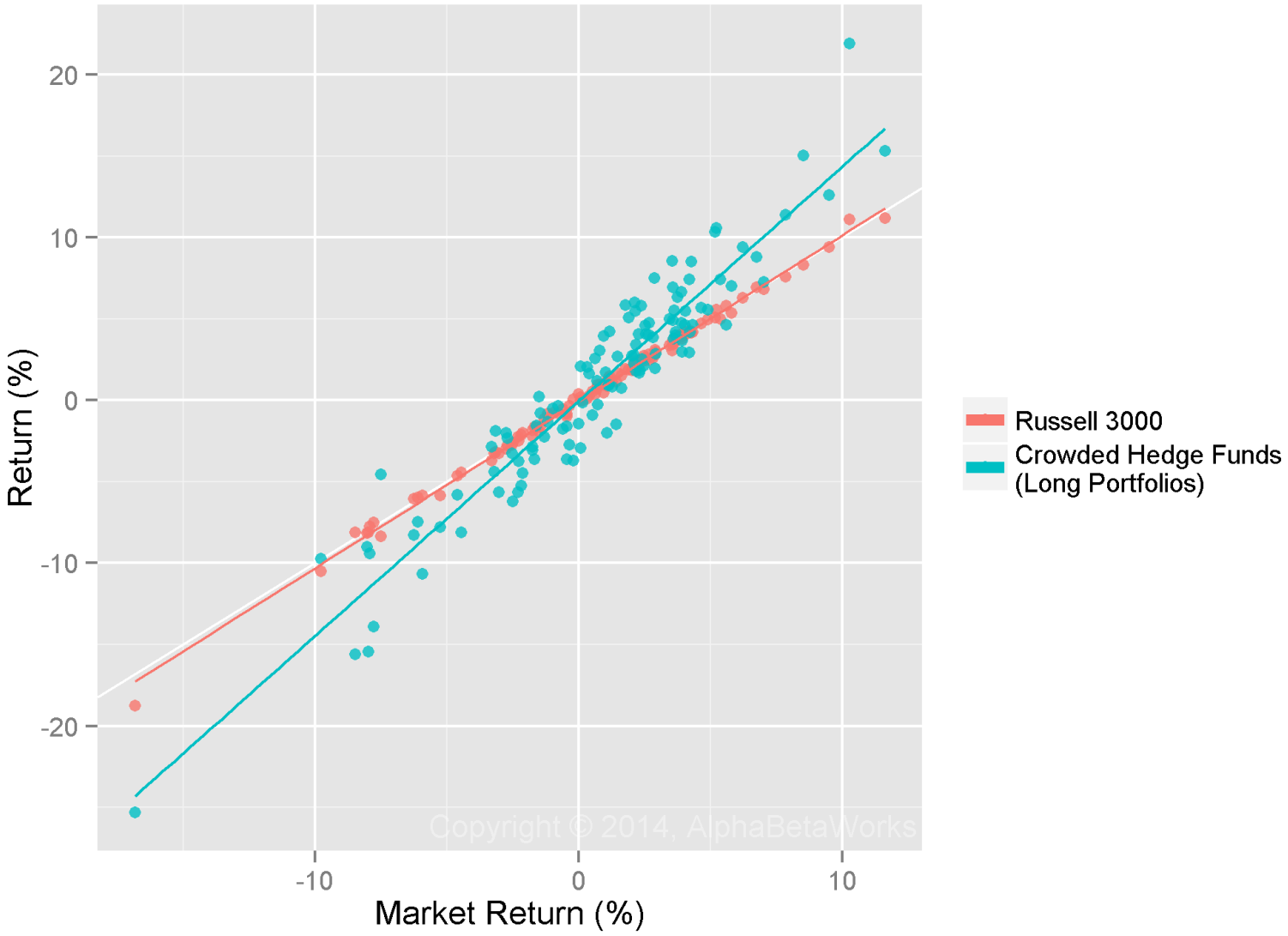
What is Alpha?



What Investors Want



What Investors (Often) Get



Put Differently

What Investors Want

What Investors Get

Volatility as Distance

$$\sigma_p = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \, \sigma_i \sigma_j \rho_{ij}}$$

$\sigma_i \sigma_i \rho_{ii} = \sigma_i^2$ is the variance of asset i

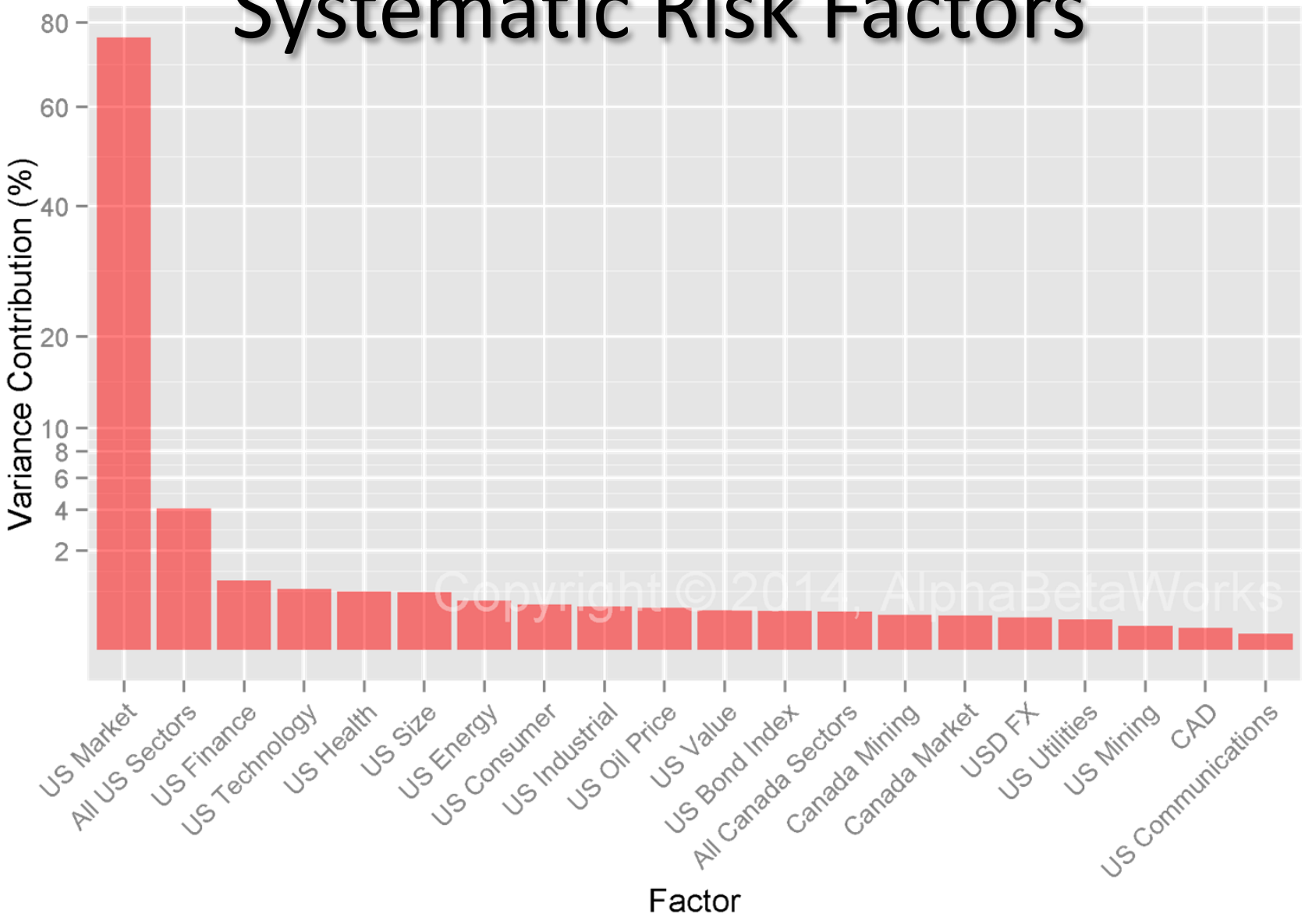
$\sigma_i \sigma_j \rho_{ij} = \sigma(i,j)$ is the covariance between assets i and j.

Factor and Residual Distances

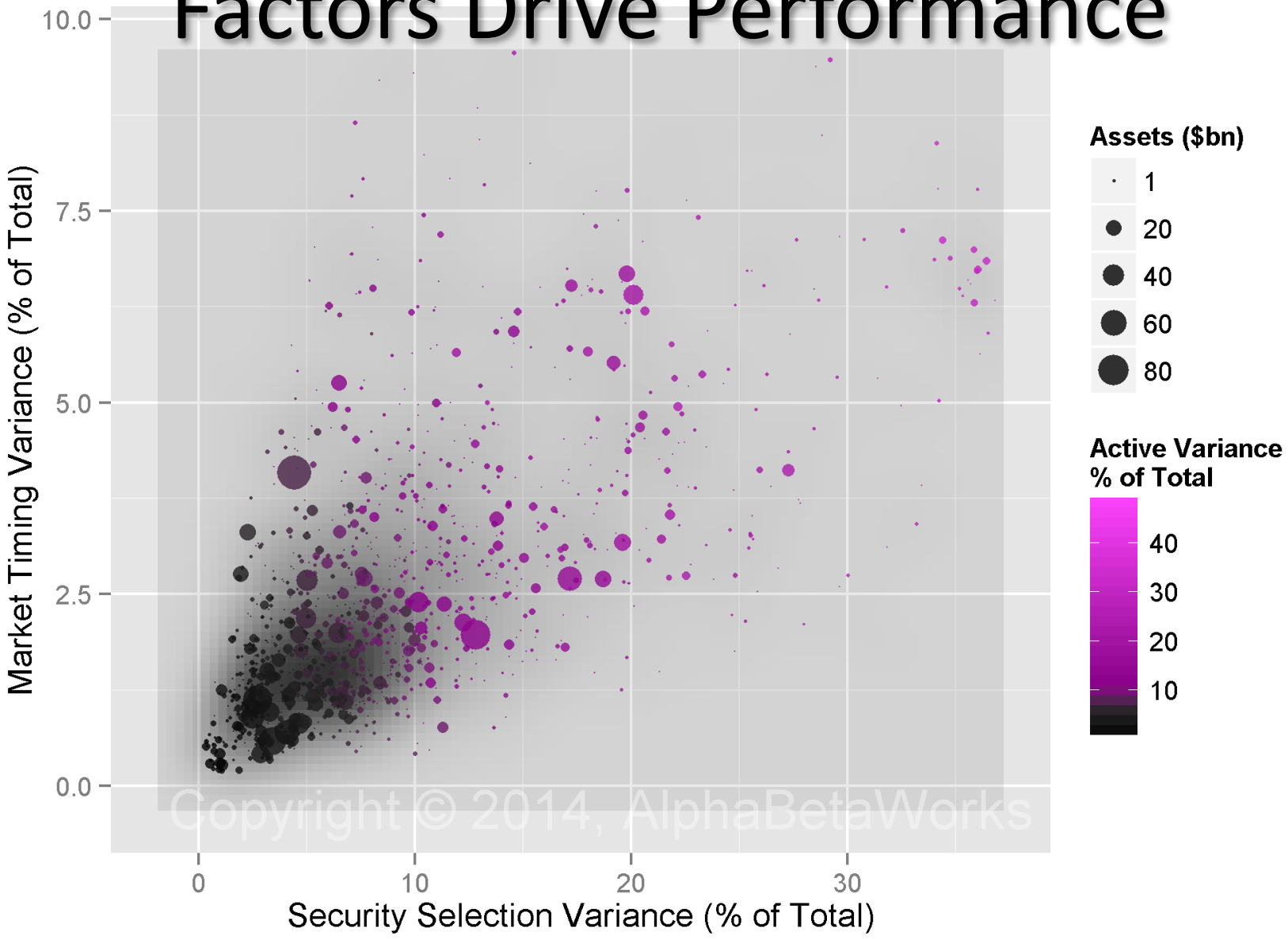
$$\sigma_p = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \, \sigma_i \sigma_j \rho_{ij}}$$

$$= \sqrt{\sum_{i=1}^{n} w_i^2 \sigma_{residual_i}^2 + \sum_{i=1}^{f}\sum_{j=1}^{f} w_i w_j \, \sigma_i \sigma_j \rho_{ij}}$$

Systematic Risk Factors



Factors Drive Performance



Estimating Factor Exposures

```r
# Exponentially weight observations:
# decay constant (0.02) (36 month ~50% decay)
kExpWeights <- exp(-1 * c(1:kDefaultRegPeriods) * .02)

# Estimate exposures using iterated re-weighted least squares (IWLS)
# Default psi = psi.huber
library(MASS)
rlm(
  y ~ x1 + x2 + x3,
  weights = head(kExpWeights, length(y)),
  acc = 0.01
)
```

sMed.X Team optimized the rlm() critical path for AlphaBetaWorks:

- Rewrote QR decomposition in MASS, currently implemented in FORTRAN, called through a C wrapper:

```
c original (dqrdc.f) linpack version dated 08/14/78 .
c g.w. stewart, university of maryland, argonne national lab.
c
c this version dated 22 august 1995
c ross ihaka
c
c bug fixes 29 September 1999 BDR (p > n case, inaccurate ranks)
```

- Added support of a response matrix in a call to rlm(), eliminating the call loop.
- Rewrote the QR algorithm in CUDA-optimized code.
- Achieved >200x performance gain on consumer hardware ($130 NVIDIA GTX 750Ti).

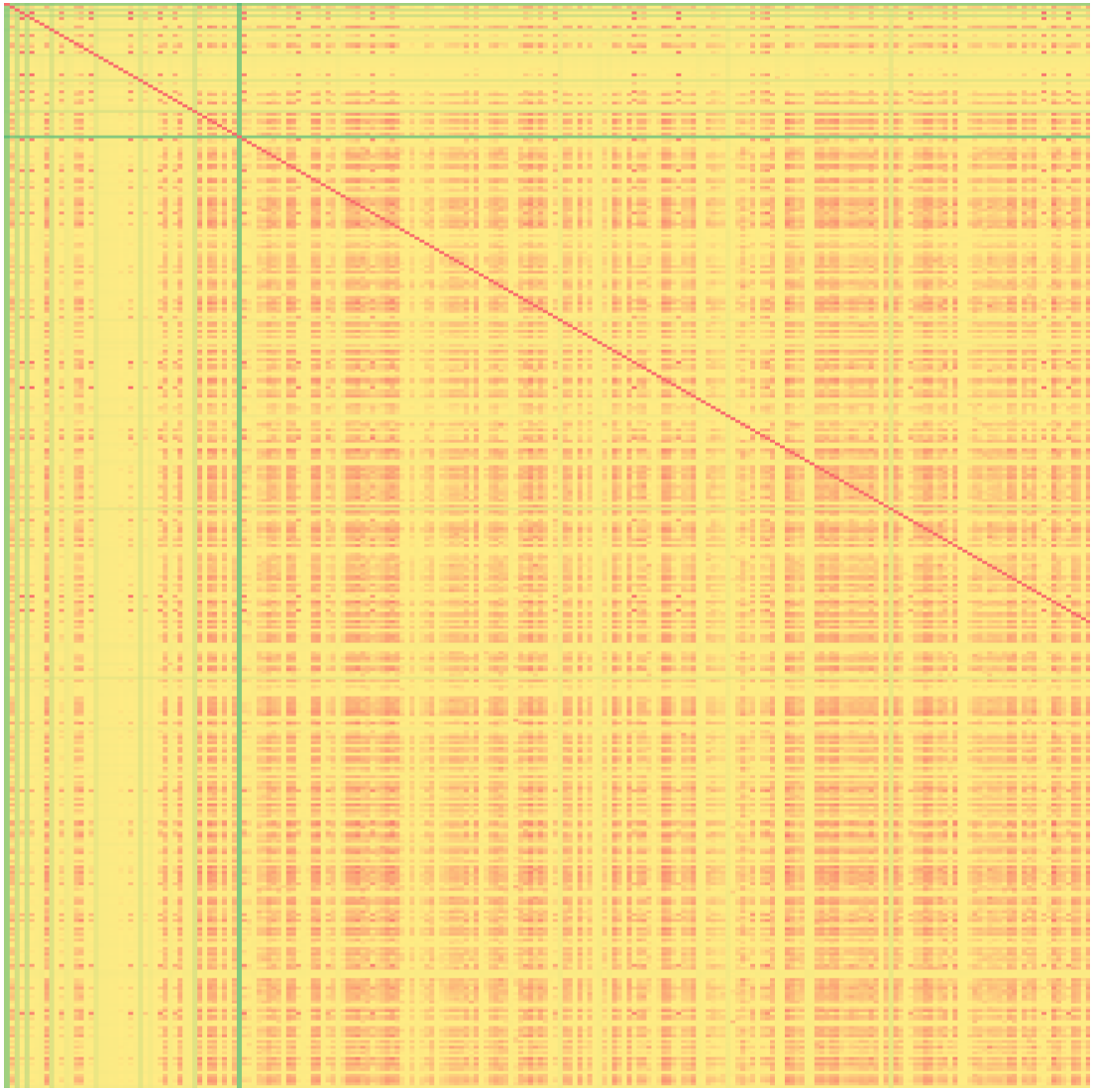
Portfolio Distance Function

```
PortfolioPairTrackingError <- function(port1, port2) {

  # Calculate relative security weightings
  pos1 <- port1$pos.last[which(port1$pos.last != 0)]
  pos2 <- port2$pos.last[which(port2$pos.last != 0)]
  secs1 <- names(pos1)
  secs2 <- names(pos2)
  secs <- union(secs1, secs2)
  port <- setNames(vector("numeric", length(secs)), secs)
  port[secs1] <- pos1[secs1]
  port[secs2] <- port[secs2] - pos2[secs2]

  # Calculate relative residual variance
  var.resid <- sum(port ^ 2 * risk.model$sec.info[secs, "ResidVar"])

  # Calculate relative factor variance
  fact.exps <- port1$fact.exps.last - port2$fact.exps.last
  fact.exp.mat <- fact.exps %*% fact.exps
  var.fact <- sum(fact.exp.mat * risk.model$fact.cov.mat)

  return(sqrt(var.resid + var.fact))
}
```

Calculating Relative Distances

```
library(doParallel)

n.workers <- 36
cl <- makeCluster(n.workers)

registerDoParallel(cl)

tracking.errors <- foreach(
  port.pair = port.pairs,
  .combine = c,
  .errorhandling = 'stop',
  .verbose = TRUE
) %dopar% PortfolioPairTrackingError(
    portfolios[[port.pair$p1]],
    portfolios[[port.pair$p2]]
)

stopCluster(cl)
```

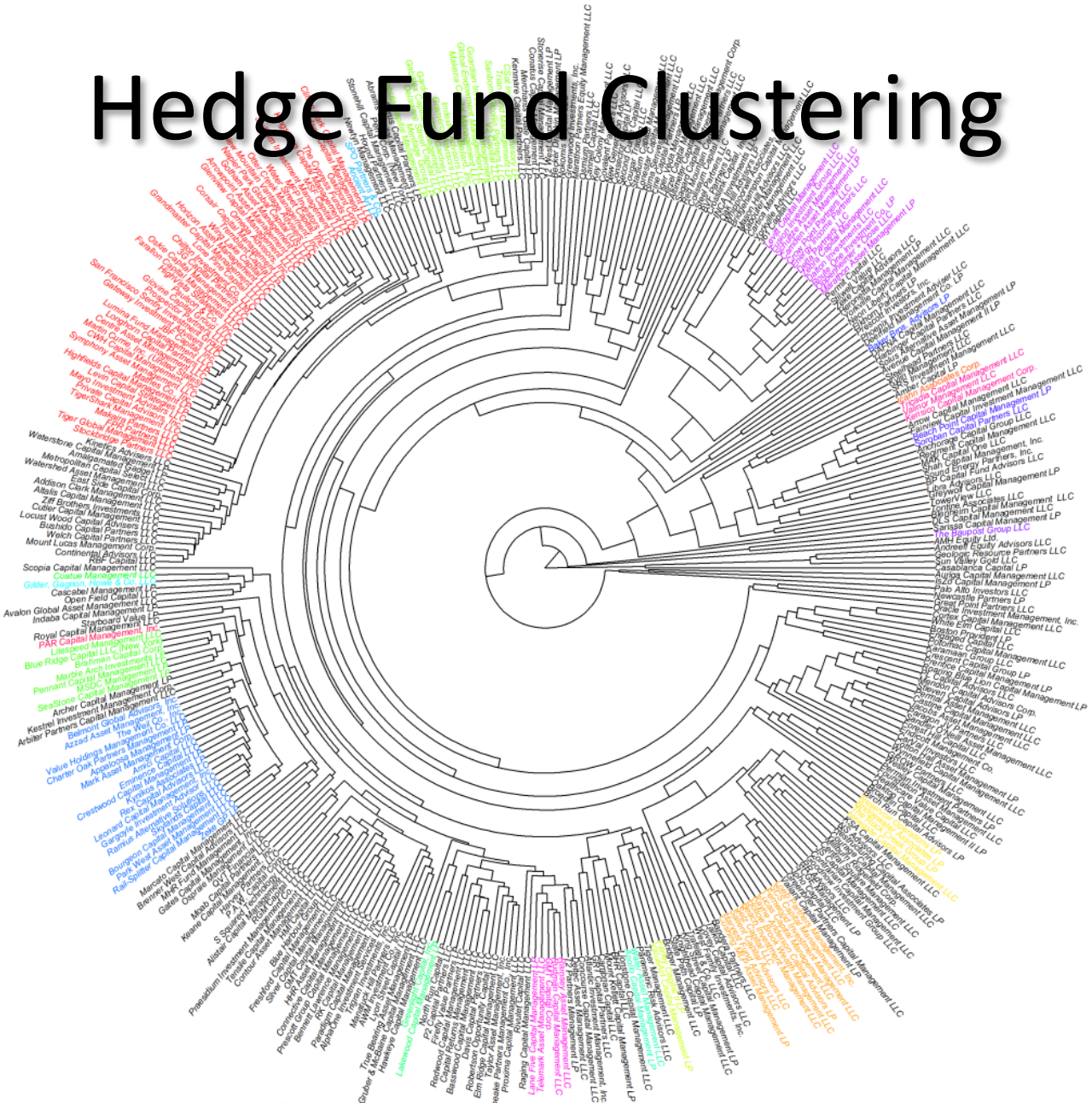
Hedge Fund Distance Matrix



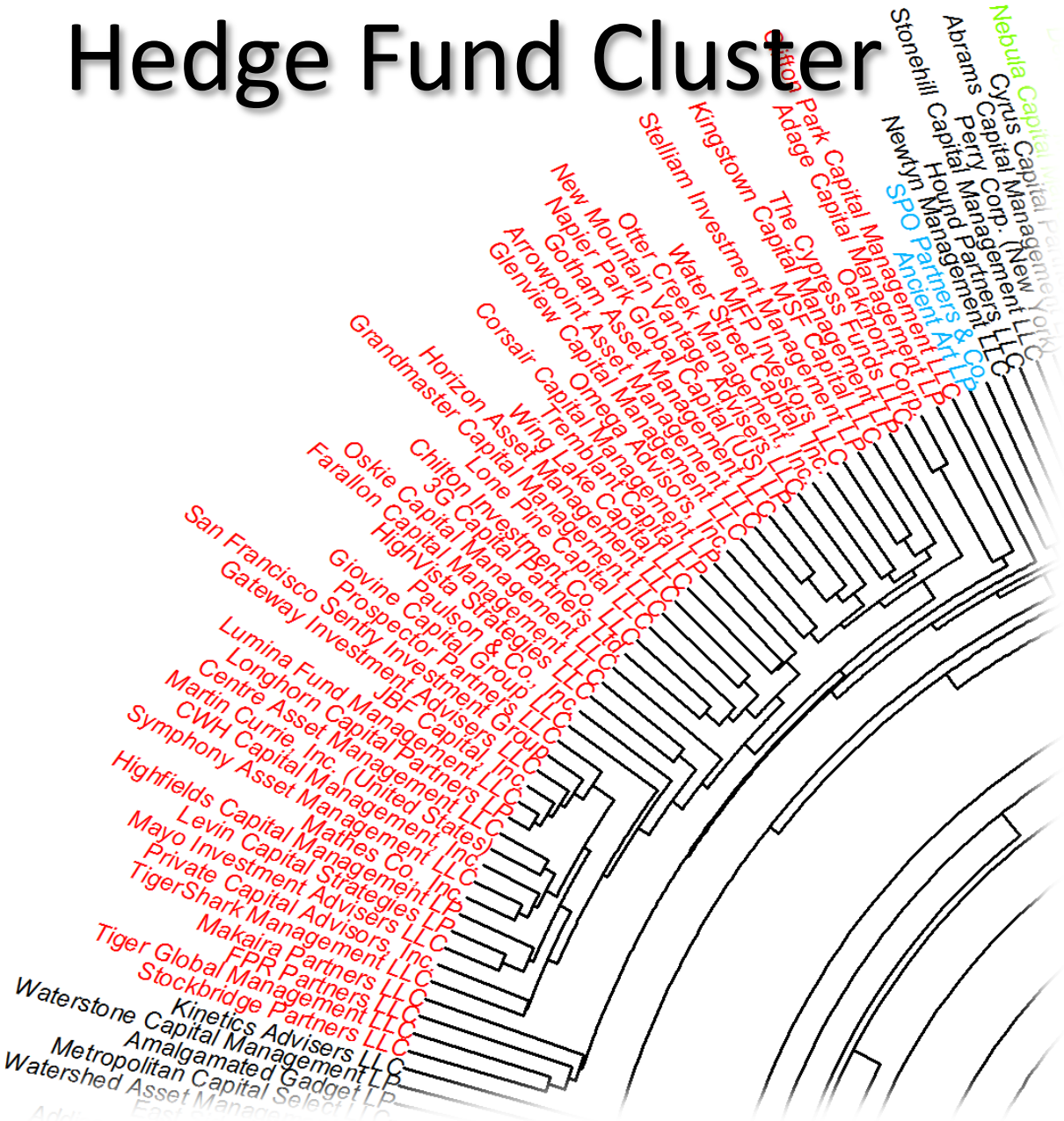
Visualizing the Distance Matrix

```
# Convert tracking error matrix to distance matrix
plot.d.mat <- as.dist(plot.mat)

# Create clusters
hc <- hclust(plot.d.mat, method = "complete")

# Cut dendrogram at h = 10
# Creates clusters with <= 10% forecasted relative tracking errors
clus = cutree(hc, h = 10)

# Plot phylogenic tree of hedge fund portfolios
pal <- rainbow(20)
plot(
  as.phylo(hc),
  type = "fan",
  cex = 0.5,
  tip.color = pal[clus],
  label.offset = 0.01
)
```

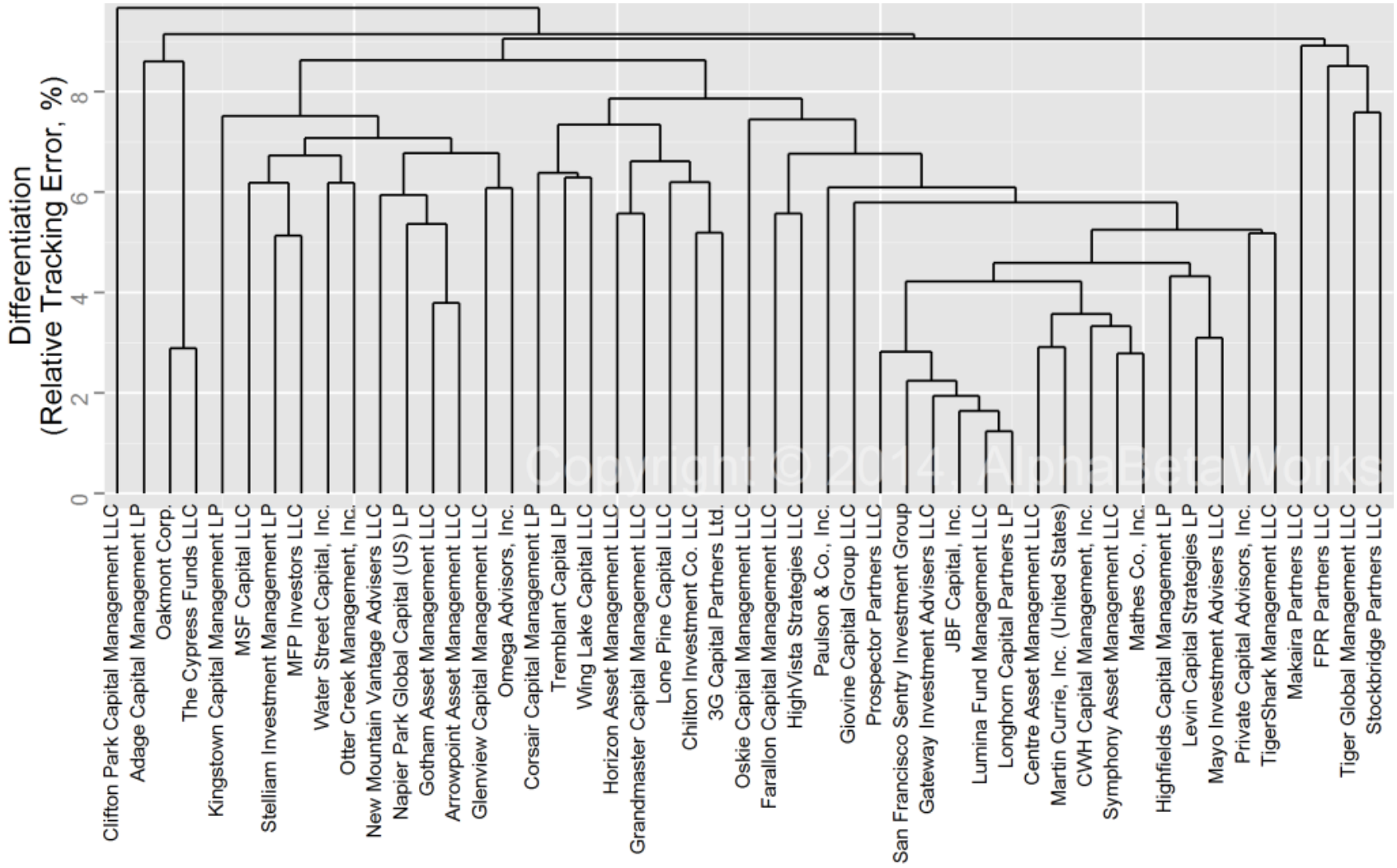
Hedge Fund Clustering



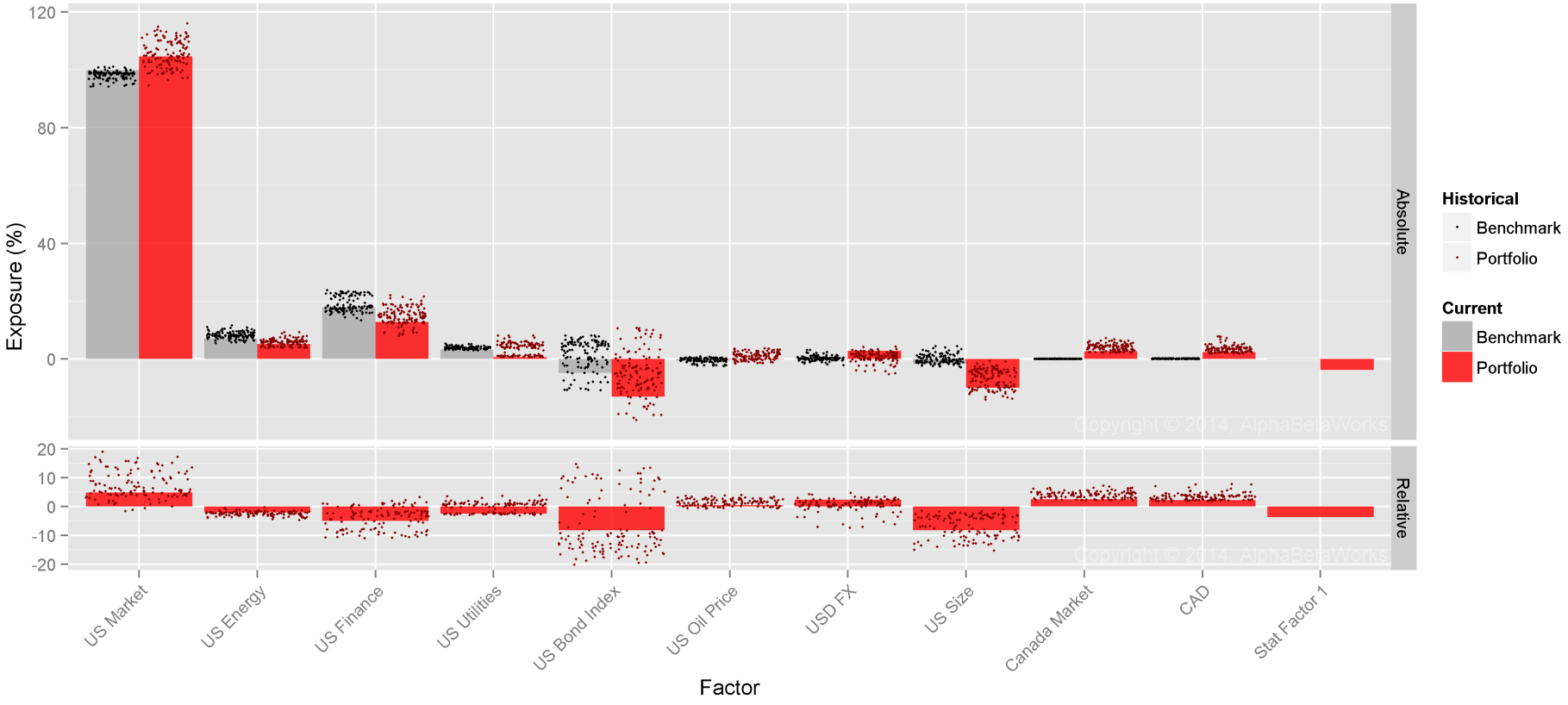
Hedge Fund Cluster



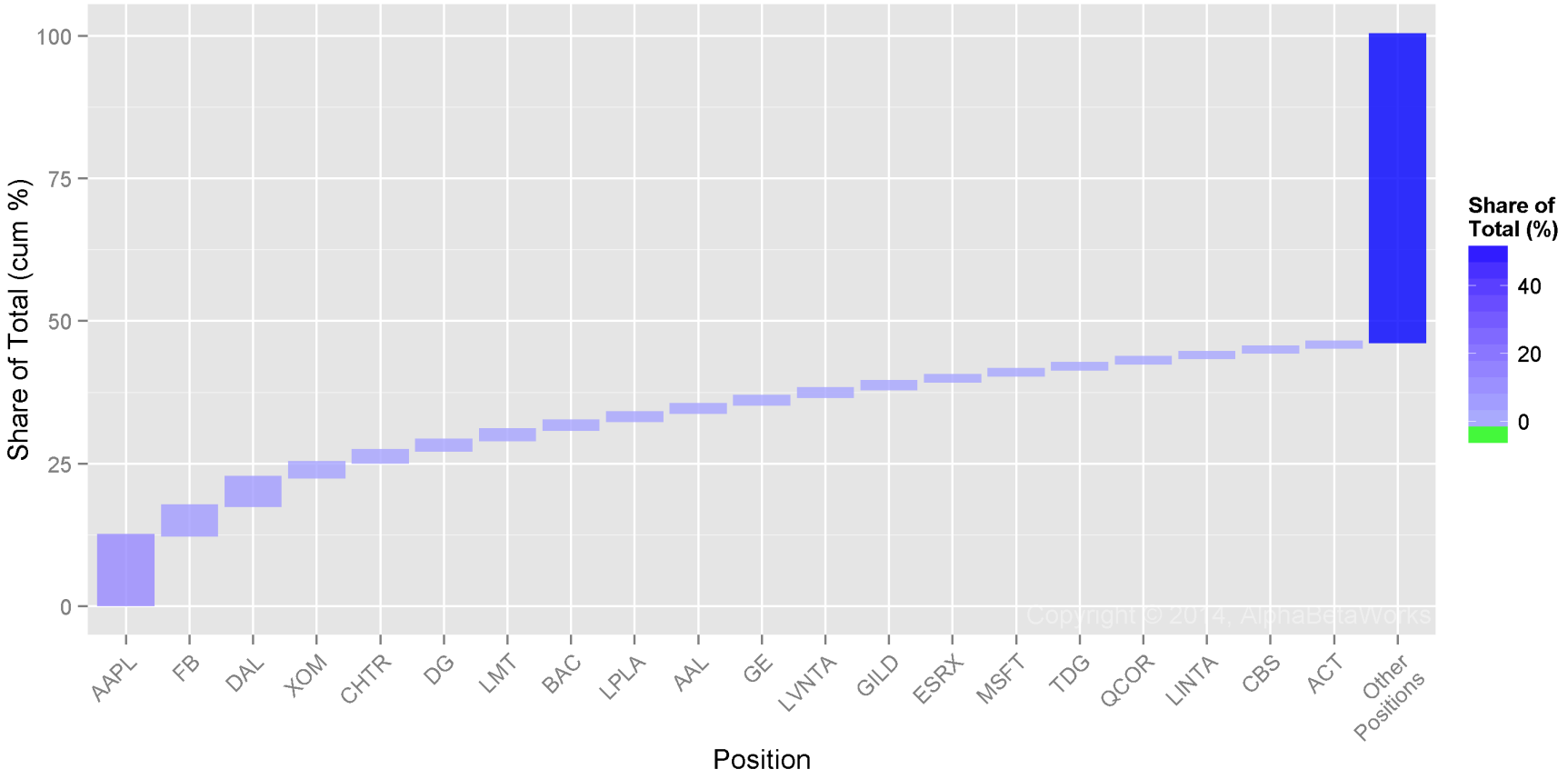
Hedge Fund Cluster



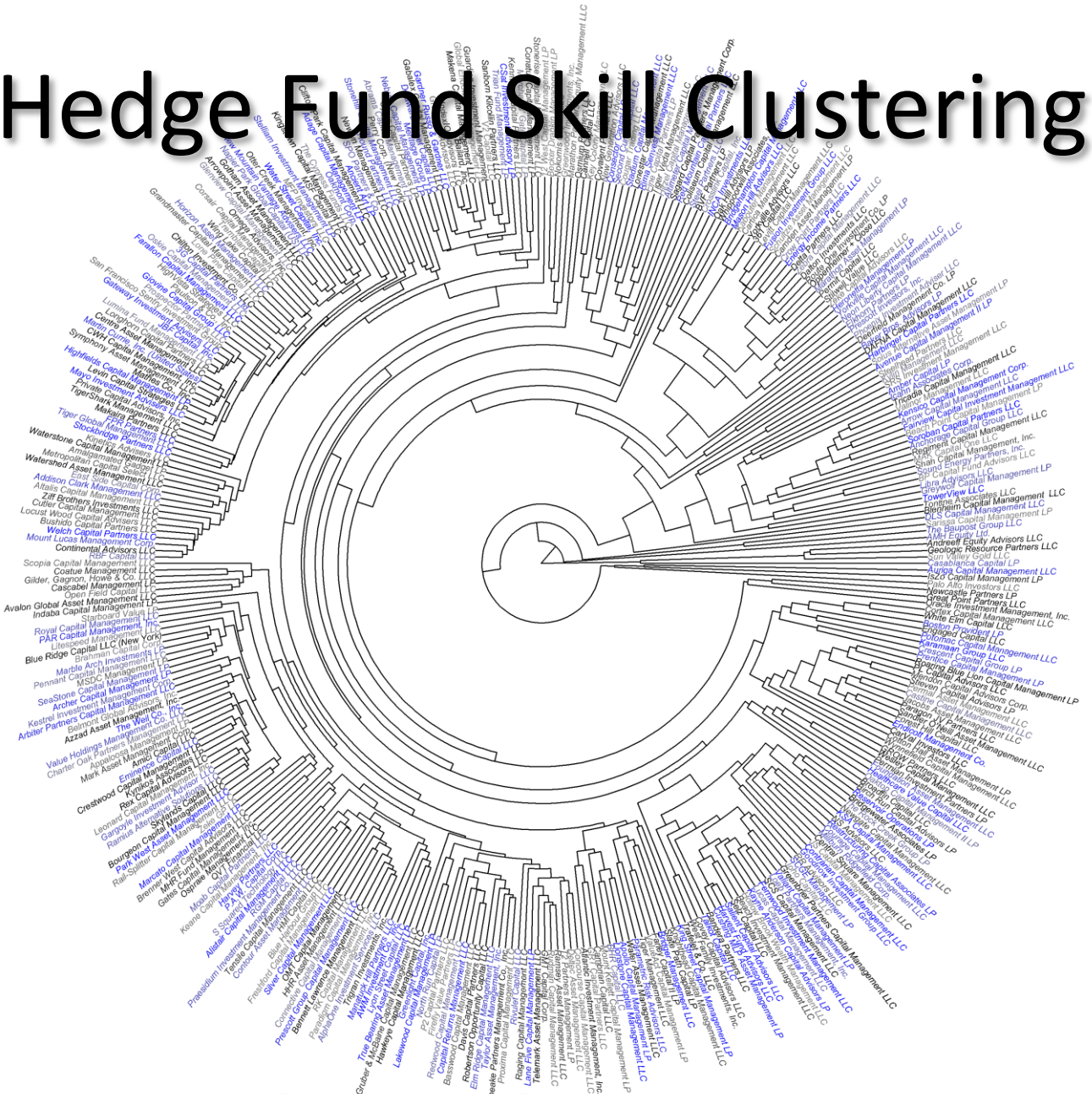
Cluster's Factor Bets



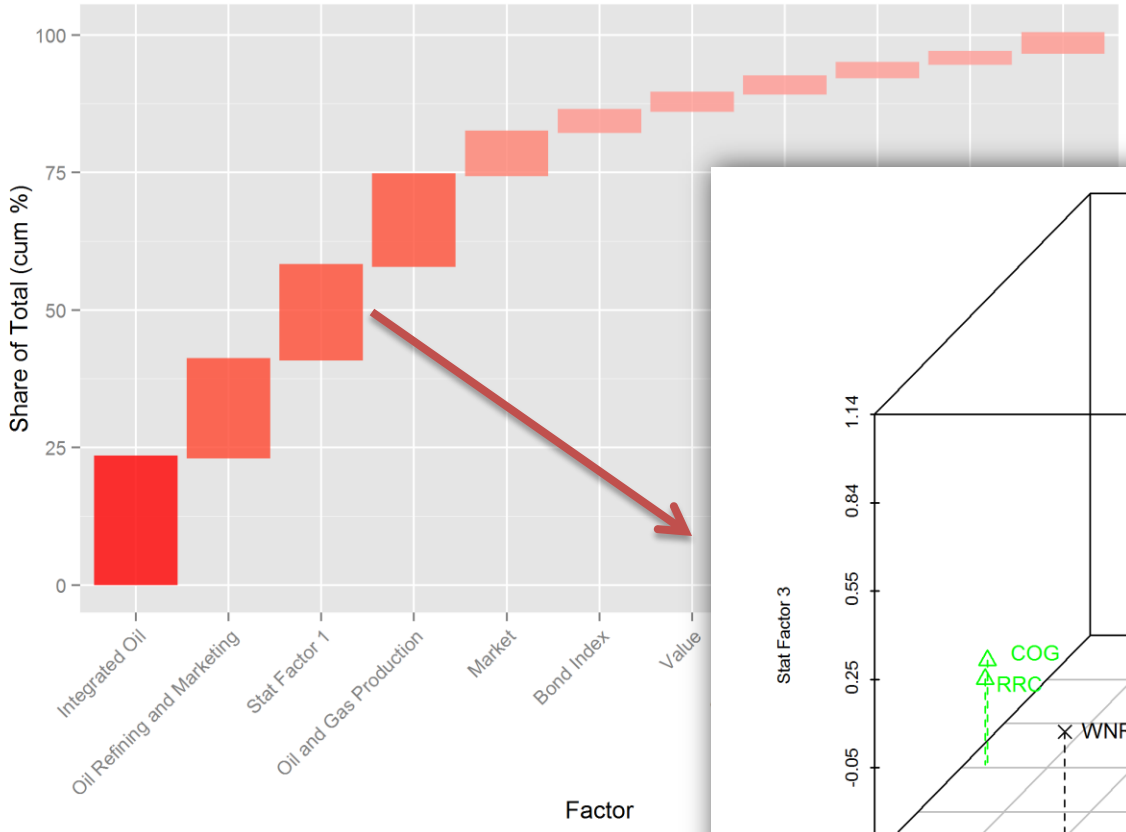
Cluster's Residual Bets

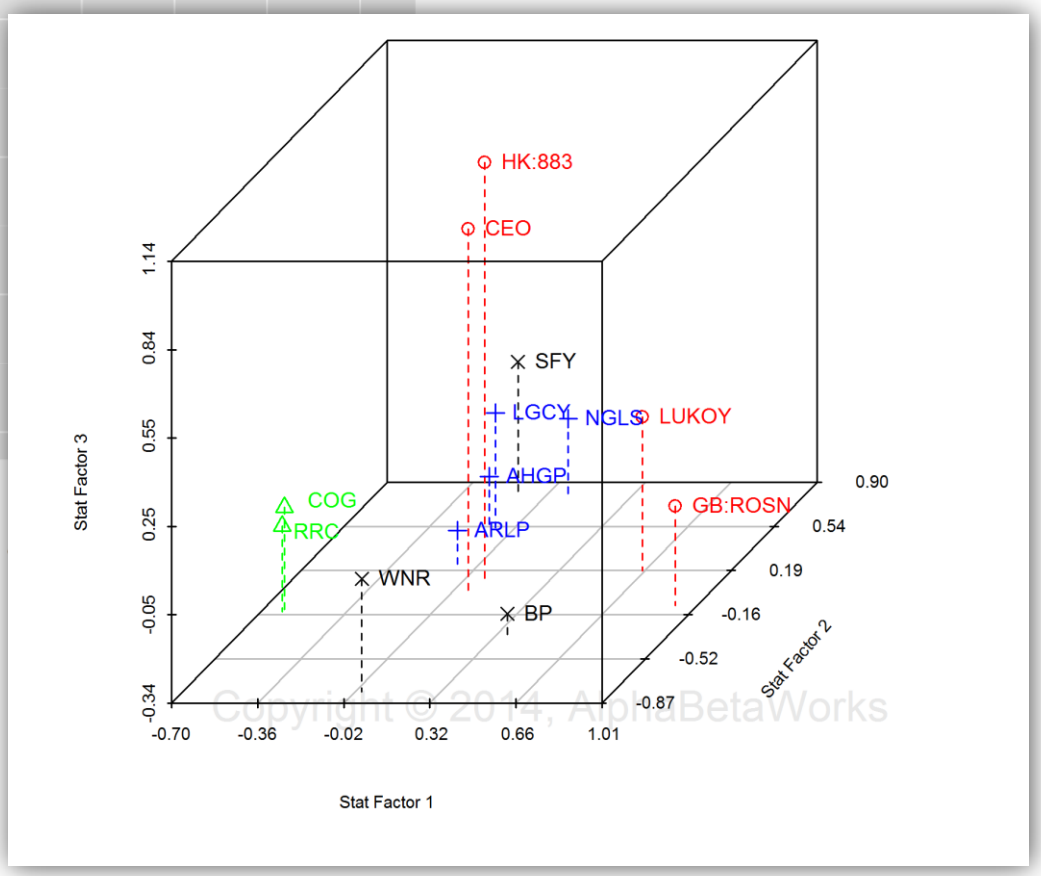


Hedge Fund Skill Clustering

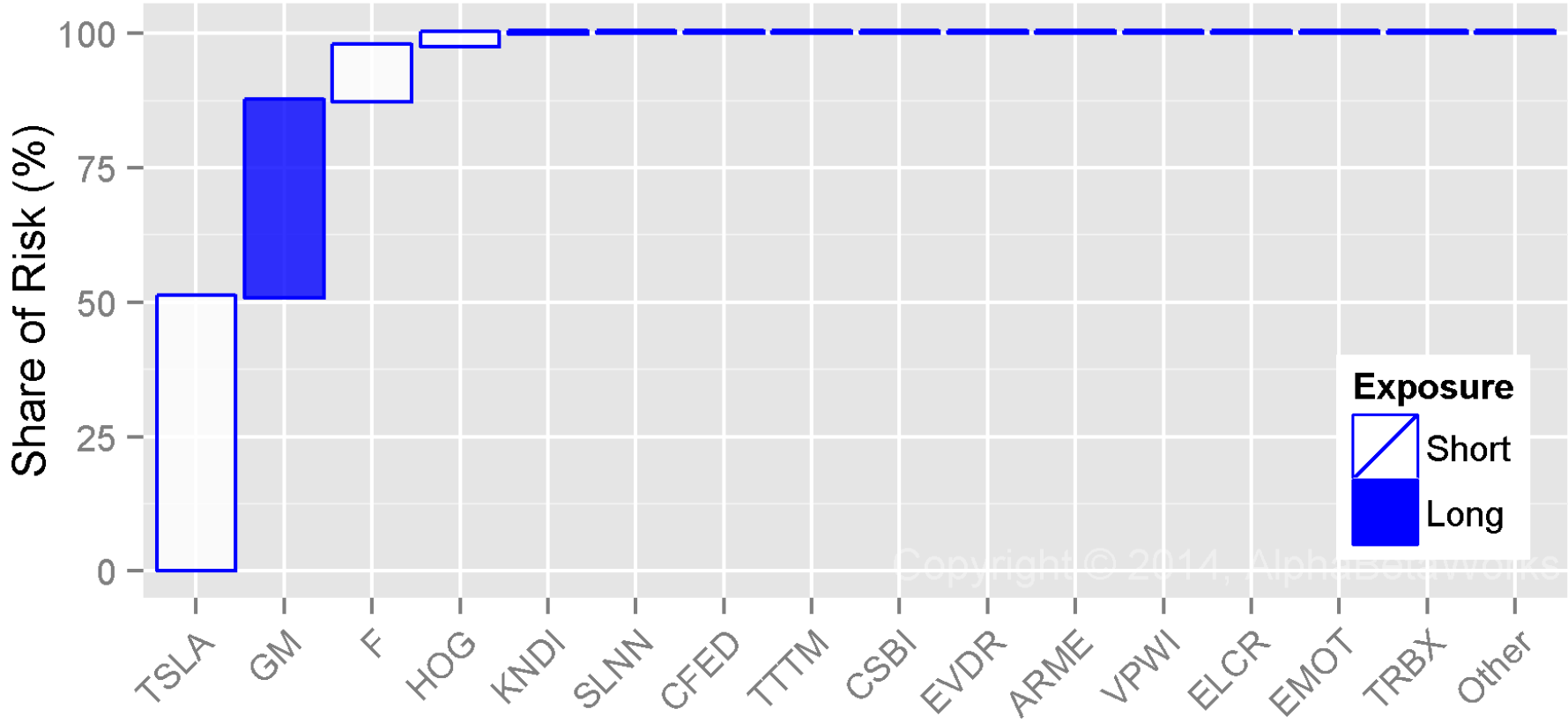


Cluster-Specific Factors





Scary Cluster



Thank You!

Resources

- Wikipedia. *Modern Portfolio Theory.* http://en.wikipedia.org/wiki/Modern_portfolio_theory
- Wikipedia. *Phylogenic Trees.* http://en.wikipedia.org/wiki/Phylogenetic_tree
- Wikipedia. *Cluster Analysis*. http://en.wikipedia.org/wiki/Cluster_analysis
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- Steve Weston (2014, April 10). *Using the foreach Package.* http://cran.r-project.org/web/packages/foreach/vignettes/foreach.pdf
- AlphaBetaWorks (2014, October 20). *Hedge Fund Clustering.* http://abwinsights.com/2014/10/20/hedge-fund-clustering/
- AlphaBetaWorks Insights and AlphaBetaWorks Charts. *Applied Financial Analytics.* http://abwinsights.com http://abwcharts.com

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