CAPM and other Statistics for HSI Components Version 1.1

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†Itself

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1 Introduction

CAPM Analysis on Hang Seng Index Components .
Hang Seng Index itself is used as the benchmark.

In finance, the capital asset pricing model (CAPM) is used to determine a theoretically appropriate required rate of return of an asset, if that asset is to be added to an already well-diversified portfolio, given that asset's non-diversifiable risk. The model takes into account the asset's sensitivity to non-diversifiable risk (also known as systematic risk or market risk), often represented by the quantity beta in the financial industry, as well as the expected return of the market and the expected return of a theoretical risk-free asset.

The model was introduced by Jack Treynor (1961, 1962),[1] William Sharpe (1964), John Lintner (1965a,b) and Jan Mossin (1966) independently, building on the earlier work of Harry Markowitz on diversification and modern portfolio theory. Sharpe, Markowitz and Merton Miller jointly received the Nobel Memorial Prize in Economics for this contribution to the field of financial economics.[1]

We attempt to show the CAPM data for all HSI components with data from Yahoo starting with 2009-01-01 and generate some more charts and statistics on the way.

This document is generated on a daily basis to have snapshots of the data for further study , if one is so inclined.

[1] Wikipedia

2 CAPM Analysis

The general idea behind CAPM is that investors need to be compensated in two ways: time value of money and risk. The time value of money is represented by the risk-free (rf) rate in the formula and compensates the investors for placing money in any investment over a period of time. The other half of the formula represents risk and calculates the amount of compensation the investor needs for taking on additional risk. This is calculated by taking a risk measure (beta) that compares the returns of the asset to the market over a period of time and to the market premium (Rm-rf).[2]

2.1 HSI Components CAPM with HSI as benchmark

CAPM - Combined

```
## Warning message: missing values removed from data
##                      HSI Components to HSI
## Alpha                               -0.0004
## Beta                                 0.0109
## Beta+                               -0.3850
## Beta-                                0.2413
## R-squared                            0.0000
## Annualized Alpha                    -0.1031
## Correlation                          0.0070
## Correlation p-value                  0.9242
## Tracking Error                       0.4614
## Active Premium                      -0.0622
## Information Ratio                   -0.1347
## Treynor Ratio                      -15.5172
```

[2] http://www.investopedia.com/terms/c/capm.asp

CAPM - Distinct for each stock

```
## Error: 'names' attribute [50] must be the same length as the vector [49]
##                      X0001.HK to HSI X0002.HK to HSI X0003.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           1.046           0.234           0.313
## Beta+                          1.062           0.046          -0.076
## Beta-                          1.016           0.272           0.513
## R-squared                      0.737           0.140           0.188
## Annualized Alpha              -0.059           0.005           0.112
## Correlation                    0.858           0.374           0.433
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.163           0.250           0.246
## Active Premium                -0.065           0.165           0.244
## Information Ratio             -0.400           0.660           0.988
## Treynor Ratio                 -0.276          -0.248           0.065
##                      X0004.HK to HSI X0005.HK to HSI X0006.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           1.201           1.010           0.143
## Beta+                          1.225           0.923          -0.062
## Beta-                          1.166           1.108           0.213
## R-squared                      0.629           0.794           0.035
## Annualized Alpha              -0.030          -0.040           0.017
## Correlation                    0.793           0.891           0.187
## Correlation p-value            0.000           0.000           0.003
## Tracking Error                 0.246           0.134           0.297
## Active Premium                -0.087          -0.040           0.190
## Information Ratio             -0.352          -0.301           0.639
## Treynor Ratio                 -0.258          -0.261          -0.235
##                      X0011.HK to HSI X0012.HK to HSI X0013.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           0.656           0.999           1.036
## Beta+                          0.668           0.966           0.972
## Beta-                          0.742           0.968           1.111
## R-squared                      0.573           0.589           0.670
## Annualized Alpha              -0.057          -0.023          -0.094
## Correlation                    0.757           0.768           0.818
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.173           0.217           0.190
## Active Premium                 0.020          -0.035          -0.092
## Information Ratio              0.113          -0.161          -0.487
## Treynor Ratio                 -0.310          -0.258          -0.305
##                      X0016.HK to HSI X0017.HK to HSI X0019.HK to HSI
## Alpha                          0.000          -0.001          -0.001
## Beta                           0.909           1.107           0.703
## Beta+                          0.998           0.712           0.706
## Beta-                          0.726           1.293           0.645
## R-squared                      0.564           0.453           0.337
## Annualized Alpha              -0.087          -0.154          -0.163
## Correlation                    0.751           0.673           0.581
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.209           0.318           0.268
## Active Premium                -0.065          -0.172          -0.095
## Information Ratio             -0.310          -0.540          -0.354
## Treynor Ratio                 -0.317          -0.357          -0.452
##                      X0023.HK to HSI X0066.HK to HSI X0083.HK to HSI
## Alpha                          0.000           0.000           0.000
```

```
## Beta                          0.890           0.521           1.174
## Beta+                         1.061           0.479           1.306
## Beta-                         0.816           0.554           1.255
## R-squared                     0.536           0.444           0.562
## Annualized Alpha             -0.030           0.002           0.064
## Correlation                   0.732           0.666           0.750
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.218           0.197           0.274
## Active Premium               -0.018           0.099          -0.020
## Information Ratio            -0.081           0.503          -0.071
## Treynor Ratio                -0.270          -0.239          -0.207
##                     X0101.HK to HSI X0144.HK to HSI X0151.HK to HSI
## Alpha                         0.000           0.000           0.002
## Beta                          1.073           1.168           0.660
## Beta+                         1.117           1.334           0.527
## Beta-                         1.143           1.204           0.839
## R-squared                     0.578           0.509           0.200
## Annualized Alpha              0.006          -0.126           0.602
## Correlation                   0.760           0.714           0.447
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.240           0.302           0.355
## Active Premium               -0.033          -0.159           0.512
## Information Ratio            -0.139          -0.526           1.443
## Treynor Ratio                -0.239          -0.327           0.437
##                     X0267.HK to HSI X0291.HK to HSI X0293.HK to HSI
## Alpha                        -0.002           0.000          -0.001
## Beta                          1.168           0.753           0.737
## Beta+                         1.492           0.742           0.964
## Beta-                         1.015           0.902           0.637
## R-squared                     0.547           0.337           0.354
## Annualized Alpha             -0.330          -0.118          -0.191
## Correlation                   0.740           0.580           0.595
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.280           0.282           0.268
## Active Premium               -0.300          -0.070          -0.124
## Information Ratio            -1.072          -0.248          -0.461
## Treynor Ratio                -0.448          -0.390          -0.470
##                     X0322.HK to HSI X0330.HK to HSI X0386.HK to HSI
## Alpha                         0.000          -0.001           0.000
## Beta                          0.446           1.127           0.790
## Beta+                         0.706           1.100           0.730
## Beta-                         0.492           1.274           0.580
## R-squared                     0.115           0.156           0.477
## Annualized Alpha             -0.070          -0.270           0.083
## Correlation                   0.339           0.394           0.691
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.353           0.684           0.222
## Active Premium                0.019          -0.345           0.095
## Information Ratio             0.054          -0.504           0.428
## Treynor Ratio                -0.458          -0.504          -0.162
##                     X0388.HK to HSI X0494.HK to HSI X0688.HK to HSI
## Alpha                        -0.001           0.000           0.002
## Beta                          1.082           1.224           1.571
## Beta+                         1.164           1.149           2.292
## Beta-                         1.017           1.048           1.329
## R-squared                     0.682           0.417           0.559
## Annualized Alpha             -0.207           0.144           0.548
```

```
## Correlation                   0.826           0.646           0.748
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.194           0.381           0.393
## Active Premium               -0.186          -0.002           0.171
## Information Ratio            -0.960          -0.004           0.436
## Treynor Ratio                -0.378          -0.184          -0.033
##                      X0700.HK to HSI X0762.HK to HSI X0836.HK to HSI
## Alpha                          0.001          -0.001           0.000
## Beta                           1.041           0.954           0.472
## Beta+                          1.348           1.109           0.238
## Beta-                          0.962           1.007           0.604
## R-squared                      0.489           0.416           0.126
## Annualized Alpha               0.255          -0.234           0.088
## Correlation                    0.700           0.645           0.355
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.277           0.294           0.352
## Active Premium                 0.151          -0.200           0.148
## Information Ratio              0.546          -0.678           0.421
## Treynor Ratio                 -0.069          -0.443          -0.159
##                      X0857.HK to HSI X0883.HK to HSI X0939.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           0.937           1.394           1.094
## Beta+                          0.868           1.684           1.149
## Beta-                          0.926           1.405           1.056
## R-squared                      0.655           0.753           0.770
## Annualized Alpha               0.106           0.006          -0.018
## Correlation                    0.809           0.868           0.878
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.178           0.232           0.158
## Active Premium                 0.084          -0.098          -0.044
## Information Ratio              0.471          -0.421          -0.277
## Treynor Ratio                 -0.149          -0.230          -0.244
##                      X0941.HK to HSI X1044.HK to HSI X1088.HK to HSI
## Alpha                          0.001           0.001           0.000
## Beta                           0.531           0.645           1.202
## Beta+                          0.320           0.836           1.225
## Beta-                          0.503           0.699           1.220
## R-squared                      0.370           0.278           0.692
## Annualized Alpha               0.236           0.216          -0.077
## Correlation                    0.608           0.527           0.832
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.218           0.286           0.215
## Active Premium                 0.296           0.227          -0.115
## Information Ratio              1.359           0.793          -0.536
## Treynor Ratio                  0.137           0.006          -0.282
##                      X1109.HK to HSI X1199.HK to HSI X1299.HK to HSI
## Alpha                          0.002          -0.001           0.001
## Beta                           1.546           1.406           0.865
## Beta+                          2.170           1.386           0.803
## Beta-                          1.218           1.549           1.122
## R-squared                      0.505           0.610           0.446
## Annualized Alpha               0.688          -0.130           0.168
## Correlation                    0.711           0.781           0.668
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.423           0.311           0.254
## Active Premium                 0.251          -0.204           0.136
## Information Ratio              0.594          -0.657           0.537
```

```
## Treynor Ratio                0.018          -0.304          -0.101
##                     X1398.HK to HSI X1880.HK to HSI X1898.HK to HSI
## Alpha                         0.000           0.000           0.000
## Beta                          1.377           1.081           1.464
## Beta+                         1.633           1.311           1.578
## Beta-                         1.227           0.930           1.365
## R-squared                     0.815           0.388           0.668
## Annualized Alpha              0.050           0.038          -0.042
## Correlation                   0.903           0.623           0.818
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.197           0.354           0.294
## Active Premium               -0.058          -0.036          -0.154
## Information Ratio            -0.296          -0.103          -0.522
## Treynor Ratio                -0.205          -0.240          -0.258
##                     X1928.HK to HSI X2318.HK to HSI X2388.HK to HSI
## Alpha                         0.003           0.000           0.000
## Beta                          1.613           1.637           0.990
## Beta+                         2.254           1.990           1.024
## Beta-                         1.789           1.326           1.055
## R-squared                     0.442           0.684           0.621
## Annualized Alpha              1.260           0.049           0.146
## Correlation                   0.665           0.827           0.788
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.498           0.334           0.202
## Active Premium                0.532          -0.135           0.099
## Information Ratio             1.067          -0.403           0.489
## Treynor Ratio                 0.191          -0.218          -0.126
##                     X2600.HK to HSI X2628.HK to HSI X3328.HK to HSI
## Alpha                        -0.001           0.000           0.000
## Beta                          1.482           1.358           1.356
## Beta+                         1.649           1.407           1.387
## Beta-                         1.257           1.254           1.346
## R-squared                     0.571           0.643           0.773
## Annualized Alpha             -0.288          -0.093          -0.088
## Correlation                   0.756           0.802           0.879
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.357           0.279           0.212
## Active Premium               -0.325          -0.166          -0.152
## Information Ratio            -0.909          -0.593          -0.714
## Treynor Ratio                -0.370          -0.286          -0.276
##                     X3988.HK to HSI
## Alpha                         0.000
## Beta                          1.158
## Beta+                         1.180
## Beta-                         1.109
## R-squared                     0.749
## Annualized Alpha             -0.061
## Correlation                   0.866
## Correlation p-value           0.000
## Tracking Error                0.179
## Active Premium               -0.090
## Information Ratio            -0.505
## Treynor Ratio                -0.271
```

3 HSI Components Risk

3.1 Correlation

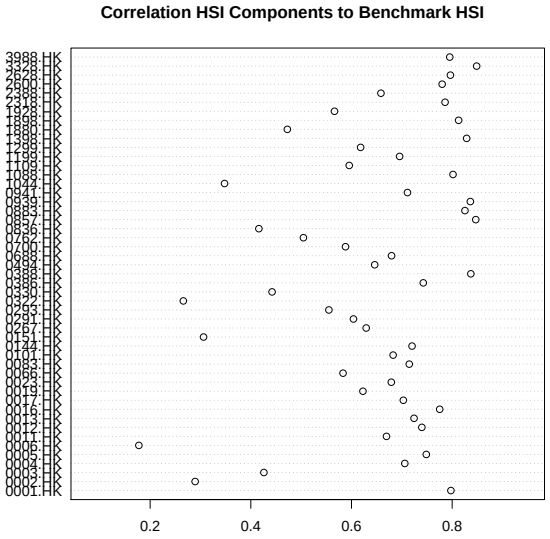
Correlation Combined

```
##                       Correlation p-value Lower CI Upper CI
## HSI Components to HSI       0.007  0.9242  -0.1804   0.1939
```

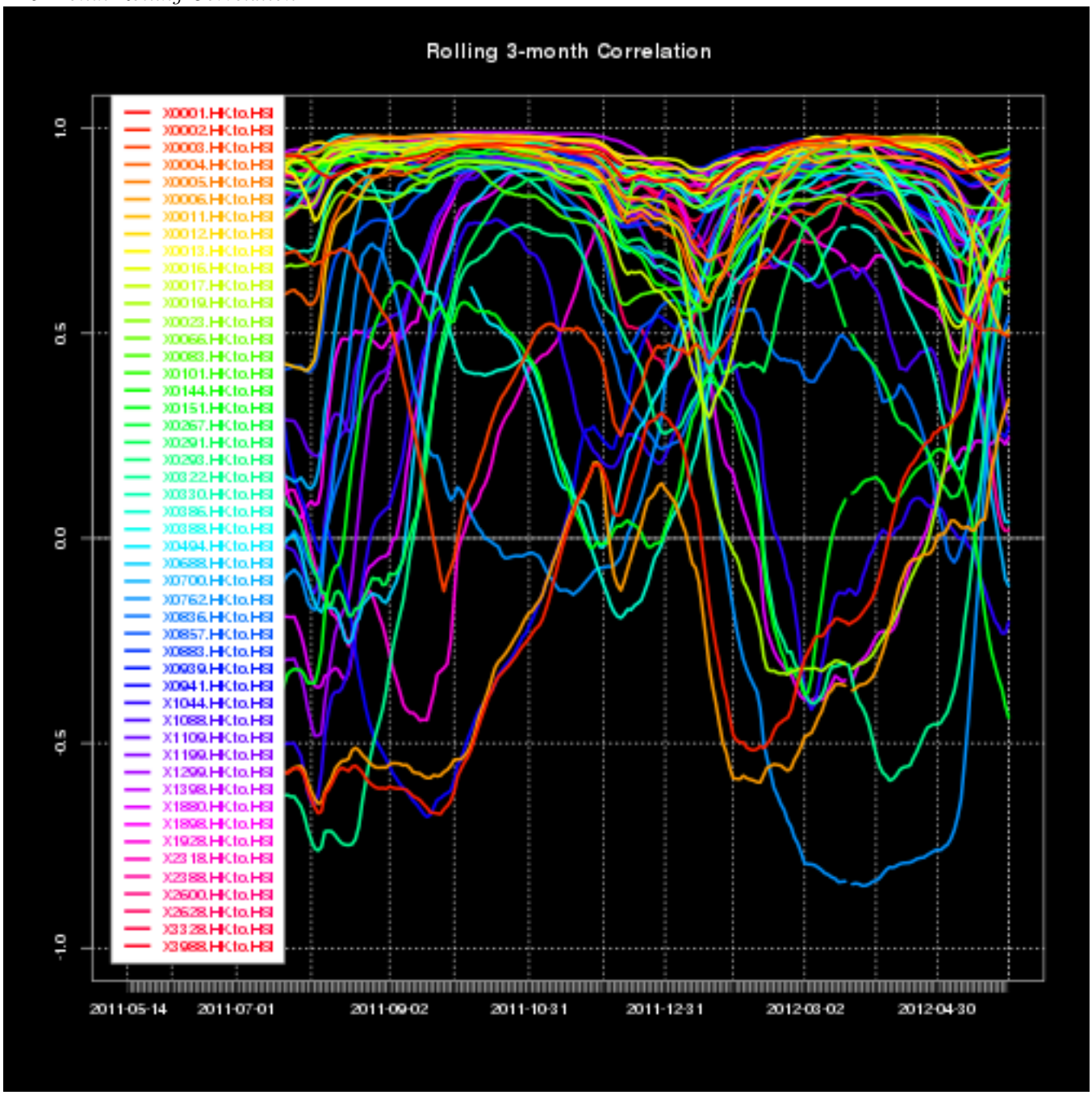
Correlation - Distinct

```
##         Correlation p-value Lower CI Upper CI
## 0001.HK      0.7975       0   0.7629   0.8276
## 0002.HK      0.2894       0   0.2063   0.3684
## 0003.HK      0.4260       0   0.3507   0.4958
## 0004.HK      0.7059       0   0.6585   0.7477
## 0005.HK      0.7486       0   0.7070   0.7851
## 0006.HK      0.1776       0   0.0905   0.2620
## 0011.HK      0.6695       0   0.6177   0.7156
## 0012.HK      0.7398       0   0.6969   0.7773
## 0013.HK      0.7243       0   0.6793   0.7638
## 0016.HK      0.7752       0   0.7373   0.8083
## 0017.HK      0.7030       0   0.6553   0.7451
## 0019.HK      0.6227       0   0.5653   0.6740
## 0023.HK      0.6791       0   0.6284   0.7241
## 0066.HK      0.5832       0   0.5217   0.6387
## 0083.HK      0.7148       0   0.6687   0.7555
## 0101.HK      0.6827       0   0.6325   0.7272
## 0144.HK      0.7203       0   0.6748   0.7603
## 0151.HK      0.3061       0   0.2237   0.3842
## 0267.HK      0.6292       0   0.5726   0.6799
## 0291.HK      0.6039       0   0.5445   0.6572
## 0293.HK      0.5551       0   0.4907   0.6134
## 0322.HK      0.2659       0   0.1817   0.3462
## 0330.HK      0.4422       0   0.3681   0.5106
## 0386.HK      0.7426       0   0.7002   0.7799
## 0388.HK      0.8371       0   0.8085   0.8617
## 0494.HK      0.6461       0   0.5399   0.7320
## 0688.HK      0.6796       0   0.6290   0.7245
## 0700.HK      0.5881       0   0.5272   0.6431
## 0762.HK      0.5045       0   0.4355   0.5676
## 0836.HK      0.4160       0   0.3401   0.4865
## 0857.HK      0.8469       0   0.8198   0.8701
## 0883.HK      0.8254       0   0.7949   0.8517
## 0939.HK      0.8361       0   0.8073   0.8609
## 0941.HK      0.7112       0   0.6646   0.7524
## 1044.HK      0.3478       0   0.2678   0.4230
## 1088.HK      0.8017       0   0.7677   0.8312
## 1109.HK      0.5955       0   0.5352   0.6497
## 1199.HK      0.6956       0   0.6469   0.7386
## 1299.HK      0.6181       0   0.5311   0.6922
## 1398.HK      0.8288       0   0.7989   0.8546
## 1880.HK      0.4726       0   0.4009   0.5385
## 1898.HK      0.8128       0   0.7805   0.8408
## 1928.HK      0.5662       0   0.4916   0.6325
## 2318.HK      0.7859       0   0.7496   0.8176
## 2388.HK      0.6585       0   0.6053   0.7058
## 2600.HK      0.7801       0   0.7429   0.8125
```

```
## 2628.HK      0.7965       0   0.7617   0.8267
## 3328.HK      0.8486       0   0.8218   0.8716
## 3988.HK      0.7952       0   0.7602   0.8256
```



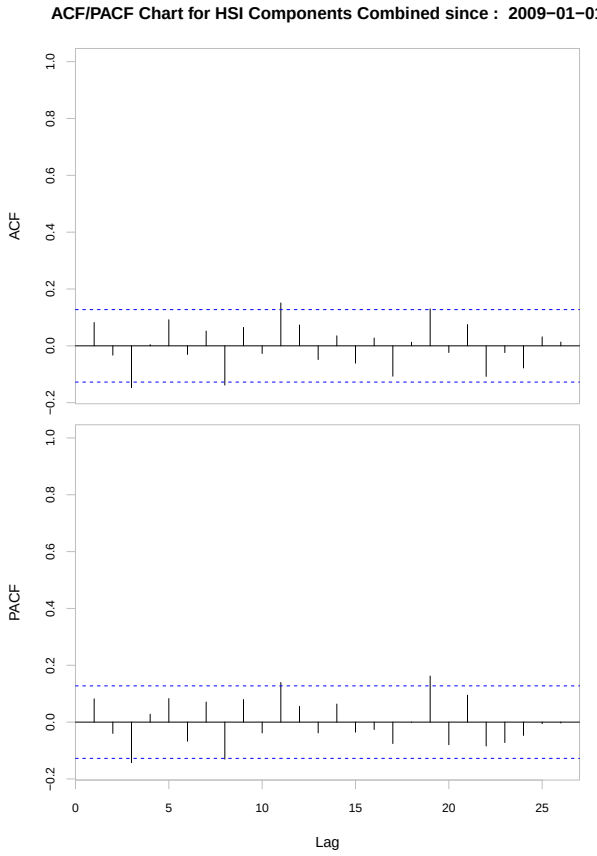
3 Month Rolling Correlation



3.2 Autocorrelation Coefficients - Combined

Autocorrelation Combined

```
##                  rho1    rho2    rho3   rho4   rho5    rho6 Q(6) p-value
## daily.returns 0.0821 -0.0328 -0.1475 0.0046 0.0919 -0.0304        0.134
```



3.3 Downside Risk - Combined

Downside Risk Combined

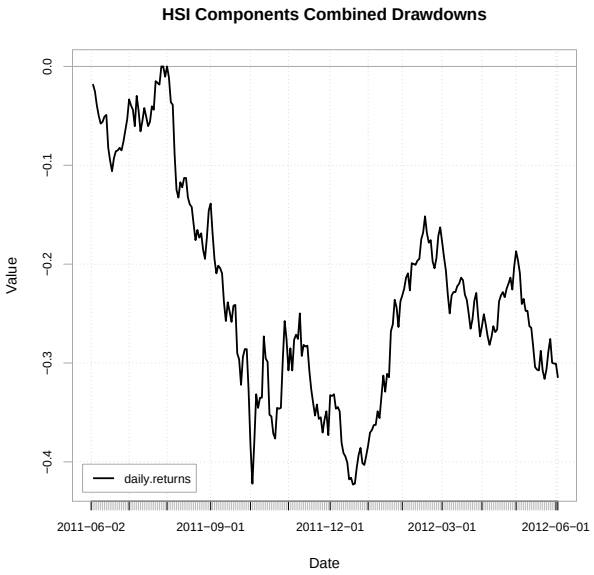
```
##                                HSI Components dailyReturn
## Semi Deviation                                      0.0239
## Gain Deviation                                      0.0178
## Loss Deviation                                      0.0156
## Downside Deviation (MAR=210%)                       0.0274
## Downside Deviation (Rf=0%)                          0.0246
## Downside Deviation (0%)                             0.0246
## Maximum Drawdown                                    0.4229
## Historical VaR (95%)                               -0.0370
## Historical ES (95%)                                -0.0538
## Modified VaR (95%)                                 -0.0391
## Modified ES (95%)                                  -0.0505
```

3.4 Drawdowns - Combined

Drawdowns Combined

```
## Warning message: Only 3 available in the data.
```

```
##         From     Trough         To   Depth Length To Trough Recovery
## 1 2011-08-02 2011-12-19       <NA> -0.4229    207        98       NA
## 2 2011-06-03 2011-06-20 2011-07-28 -0.1060     38        11       27
## 3 2011-07-29 2011-07-29 2011-08-01 -0.0104      2         1        1
```



3.5 Downside Deviation - Combined

Downside Deviation Combined

```
##                                 HSI Components
## Downside Deviation (MAR = 0%)          0.02457
```

3.6 Downside Deviation - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## Downside Deviation (MAR = 0%)  0.0191  0.0089  0.0152  0.0238  0.0247
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## Downside Deviation (MAR = 0%)   0.011  0.0147  0.0211   0.019  0.0203
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## Downside Deviation (MAR = 0%)  0.0245  0.0205  0.0202  0.0129  0.0252
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## Downside Deviation (MAR = 0%)  0.0248  0.0268  0.0217  0.0248  0.0232
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## Downside Deviation (MAR = 0%)  0.0213  0.0202  0.0349  0.0202  0.0194
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Downside Deviation (MAR = 0%)  0.0321  0.0258  0.0242   0.023  0.0202
##                                0857.HK 0883.HK 0939.HK 0941.HK 1044.HK
## Downside Deviation (MAR = 0%)  0.0205  0.0235  0.0205  0.0157  0.0204
##                                1088.HK 1109.HK 1199.HK 1299.HK 1398.HK
## Downside Deviation (MAR = 0%)   0.024  0.0286  0.0289  0.0194   0.021
##                                1880.HK 1898.HK 1928.HK 2318.HK 2388.HK
## Downside Deviation (MAR = 0%)  0.0268   0.029  0.0299  0.0264  0.0196
##                                2600.HK 2628.HK 3328.HK 3988.HK
## Downside Deviation (MAR = 0%)  0.0293  0.0221  0.0221  0.0212
```

4 General Statistics

Statistics Distinct

```
##                Observations NAs Minimum Quartile 1 Median Arithmetic Mean
## X0001.HK.Close          847  12   56.00     91.700  98.50         100.170
## X0002.HK.Close          847  12   51.10     52.700  60.15          59.803
## X0003.HK.Close          846  13   10.78     17.280  18.26          17.756
## X0004.HK.Close          846  13   15.20     37.625  42.10          41.977
## X0005.HK.Close          847  12   33.00     66.100  77.00          74.312
## X0006.HK.Close          846  13   41.10     43.700  47.92          49.689
## X0011.HK.Close          847  12   67.00    102.450 109.50         108.966
## X0012.HK.Close          847  12   23.75     42.550  47.95          46.675
## X0013.HK.Close          846  13   36.40     53.413  61.50          64.889
## X0016.HK.Close          846  13   55.80     98.362 110.85         107.604
## X0017.HK.Close          846  13    6.20      9.342  13.24          12.432
## X0019.HK.Close          846  13   42.90     84.812  91.42          92.111
## X0023.HK.Close          846  13   12.34     26.863  29.00          28.260
## X0066.HK.Close          846  13   16.14     25.250  26.90          26.101
## X0083.HK.Close          846  13    5.60     11.900  13.50          13.047
## X0101.HK.Close          847  12   13.66     25.675  28.75          28.530
## X0144.HK.Close          847  12   12.20     23.225  26.20          25.901
## X0151.HK.Close          846  13    2.77      4.970   6.31           6.071
## X0267.HK.Close          846  13    7.18     13.800  16.77          16.731
## X0291.HK.Close          846  13   10.66     24.762  27.90          26.211
## X0293.HK.Close          846  13    6.98     12.625  14.62          15.059
## X0322.HK.Close          847  12    8.27     17.320  19.42          18.459
## X0330.HK.Close          847  12    7.93     22.475  41.40          37.157
## X0386.HK.Close          846  13    3.65      6.230   6.88           6.937
## X0388.HK.Close          847  12   54.60    122.700 134.90         135.837
## X0494.HK.Close          248 611   11.60     14.070  15.18          15.384
## X0688.HK.Close          847  12    9.41     14.390  15.54          15.253
## X0700.HK.Close          855   4   41.80    130.450 158.50         153.583
## X0762.HK.Close          853   6    8.31      9.830  11.12          11.992
## X0836.HK.Close          847  12   11.10     14.140  15.20          15.342
## X0857.HK.Close          847  12    5.10      8.755   9.49           9.453
## X0883.HK.Close          846  13    6.08     11.800  13.52          13.770
## X0939.HK.Close          846  13    3.66      5.620   6.22           6.103
## X0941.HK.Close          846  13   63.00     73.650  76.35          76.306
## X1044.HK.Close          859   0   24.25     50.275  61.10          57.818
## X1088.HK.Close          847  12   13.90     30.275  33.30          31.743
## X1109.HK.Close          846  13    7.50     13.060  14.48          14.372
## X1199.HK.Close          846  13    5.40      9.470  11.06          11.109
## X1299.HK.Close          394 465   19.86     23.000  24.68          24.929
## X1398.HK.Close          846  13    3.03      4.963   5.67           5.433
## X1880.HK.Close          846  13    2.98      8.420  12.61          11.263
## X1898.HK.Close          846  13    4.43      9.095  10.40          10.301
## X1928.HK.Close          620 239    9.23     12.115  18.44          18.347
## X2318.HK.Close          846  13   30.35     58.225  64.35          65.085
## X2388.HK.Close          847  12    6.30     16.860  18.80          19.014
## X2600.HK.Close          847  12    3.09      4.355   6.79           6.420
## X2628.HK.Close          847  12   17.08     22.975  29.65          28.884
## X3328.HK.Close          847  12    4.17      5.930   7.88           7.440
## X3988.HK.Close          846  13    1.84      3.053   3.86           3.620
##                Geometric Mean Quartile 3 Maximum SE Mean LCL Mean (0.95)
## X0001.HK.Close         98.898    112.000  135.70  0.5385           99.113
## X0002.HK.Close         59.446     65.125   75.00  0.2274           59.357
## X0003.HK.Close         17.623     19.080   21.00  0.0714           17.616
```

```
## X0004.HK.Close         40.380     49.987   62.00  0.3664          41.258
## X0005.HK.Close         73.341     82.675   98.00  0.3949          73.537
## X0006.HK.Close         49.309     55.900   64.80  0.2160          49.265
## X0011.HK.Close        108.253    116.750  134.00  0.4201         108.142
## X0012.HK.Close         45.914     52.700   60.50  0.2735          46.138
## X0013.HK.Close         63.017     77.650   95.90  0.5384          63.833
## X0016.HK.Close        105.949    118.475  146.30  0.6112         106.404
## X0017.HK.Close         11.981     15.220   18.54  0.1139          12.209
## X0019.HK.Close         89.870    106.775  136.40  0.6601          90.815
## X0023.HK.Close         27.762     31.950   35.90  0.1678          27.931
## X0066.HK.Close         25.892     28.100   31.15  0.1079          25.889
## X0083.HK.Close         12.801     14.715   18.56  0.0828          12.885
## X0101.HK.Close         27.981     31.900   40.30  0.1849          28.167
## X0144.HK.Close         25.403     28.700   37.55  0.1676          25.573
## X0151.HK.Close          5.887      7.140    9.70  0.0533           5.966
## X0267.HK.Close         16.242     20.400   24.40  0.1369          16.462
## X0291.HK.Close         25.269     30.587   35.25  0.2170          25.785
## X0293.HK.Close         14.569     18.100   24.05  0.1346          14.795
## X0322.HK.Close         17.836     21.450   25.95  0.1522          18.160
## X0330.HK.Close         32.904     49.125   64.30  0.5350          36.107
## X0386.HK.Close          6.850      7.720    9.64  0.0390           6.860
## X0388.HK.Close        132.226    151.500  197.50  0.9987         133.876
## X0494.HK.Close         15.286     16.900   19.86  0.1147          15.158
## X0688.HK.Close         15.134     16.600   19.44  0.0649          15.126
## X0700.HK.Close        142.944    188.900  247.00  1.6850         150.276
## X0762.HK.Close         11.774     13.980   17.40  0.0839          11.828
## X0836.HK.Close         15.261     16.520   20.15  0.0562          15.232
## X0857.HK.Close          9.344     10.480   12.36  0.0493           9.356
## X0883.HK.Close         13.345     16.760   20.95  0.1167          13.541
## X0939.HK.Close          6.040      6.768    8.28  0.0311           6.042
## X0941.HK.Close         76.177     78.950   91.45  0.1542          76.004
## X1044.HK.Close         55.538     69.450   82.70  0.5059          56.825
## X1088.HK.Close         31.130     35.250   40.80  0.1937          31.363
## X1109.HK.Close         14.152     16.060   20.00  0.0858          14.203
## X1199.HK.Close         10.889     12.540   16.76  0.0782          10.956
## X1299.HK.Close         24.839     26.800   29.65  0.1088          24.715
## X1398.HK.Close          5.373      5.940    7.03  0.0286           5.377
## X1880.HK.Close         10.531     14.280   17.54  0.1297          11.008
## X1898.HK.Close         10.073     11.635   15.86  0.0742          10.155
## X1928.HK.Close         17.377     22.100   32.70  0.2475          17.861
## X2318.HK.Close         63.721     74.388   94.30  0.4453          64.210
## X2388.HK.Close         18.261     22.900   28.95  0.1718          18.677
## X2600.HK.Close          6.166      7.770   10.66  0.0638           6.294
## X2628.HK.Close         28.190     34.250   41.00  0.2149          28.462
## X3328.HK.Close          7.287      8.630   10.56  0.0538           7.335
## X3988.HK.Close          3.563      4.130    5.00  0.0239           3.573
##                 UCL Mean (0.95)  Variance   Stdev Skewness Kurtosis
## X0001.HK.Close         101.227  245.6238 15.6724  -0.1275   0.0269
## X0002.HK.Close          60.250   43.8018  6.6183   0.1853  -1.3817
## X0003.HK.Close          17.896    4.3104  2.0761  -1.6527   2.3115
## X0004.HK.Close          42.696  113.5445 10.6557  -0.5370   0.0349
## X0005.HK.Close          75.087  132.0928 11.4932  -0.6504   0.1411
## X0006.HK.Close          50.113   39.4720  6.2827   0.4134  -1.1872
## X0011.HK.Close         109.791  149.4758 12.2260  -0.4268   0.0809
## X0012.HK.Close          47.212   63.3650  7.9602  -0.8171   0.3005
## X0013.HK.Close          65.946  245.2545 15.6606   0.2171  -1.0511
## X0016.HK.Close         108.804  316.0758 17.7785  -0.7656   0.5260
```

```
## X0017.HK.Close          12.656   10.9814  3.3138  -0.3247  -1.1405
## X0019.HK.Close          93.406  368.6708 19.2008  -0.4015   0.1942
## X0023.HK.Close          28.589   23.8179  4.8804  -1.2904   1.4002
## X0066.HK.Close          26.313    9.8584  3.1398  -1.4676   1.6300
## X0083.HK.Close          13.210    5.7986  2.4080  -1.0255   0.9219
## X0101.HK.Close          28.893   28.9558  5.3811  -0.5056   0.1908
## X0144.HK.Close          26.230   23.7784  4.8763  -0.5107   0.5282
## X0151.HK.Close           6.175    2.4040  1.5505  -0.1787  -0.4835
## X0267.HK.Close          17.000   15.8649  3.9831  -0.2471  -0.8158
## X0291.HK.Close          26.637   39.8527  6.3129  -1.1026   0.1839
## X0293.HK.Close          15.323   15.3337  3.9158   0.1981  -0.5969
## X0322.HK.Close          18.757   19.6142  4.4288  -0.9015   0.0143
## X0330.HK.Close          38.207  242.3887 15.5688  -0.4542  -1.0397
## X0386.HK.Close           7.013    1.2856  1.1338  -0.3914   0.2986
## X0388.HK.Close         137.797  844.8344 29.0660  -0.5128   0.4337
## X0494.HK.Close          15.610    3.2601  1.8056   0.2242  -0.7210
## X0688.HK.Close          15.380    3.5684  1.8890  -0.8134   0.3472
## X0700.HK.Close         156.890 2427.5662 49.2703  -0.6655  -0.2543
## X0762.HK.Close          12.157    6.0111  2.4517   0.6105  -0.9762
## X0836.HK.Close          15.452    2.6737  1.6351   0.2740  -0.2497
## X0857.HK.Close           9.550    2.0612  1.4357  -0.7322   0.6153
## X0883.HK.Close          13.999   11.5198  3.3941  -0.2000  -0.6982
## X0939.HK.Close           6.164    0.8200  0.9055  -0.7124   0.1764
## X0941.HK.Close          76.609   20.1180  4.4853   0.1812   0.3491
## X1044.HK.Close          58.811  219.8556 14.8275  -0.7282  -0.4744
## X1088.HK.Close          32.123   31.7647  5.6360  -1.4429   1.7178
## X1109.HK.Close          14.540    6.2333  2.4967  -0.4108   0.0174
## X1199.HK.Close          11.262    5.1759  2.2751   0.0806  -0.3698
## X1299.HK.Close          25.143    4.6645  2.1597   0.0650  -1.1793
## X1398.HK.Close           5.489    0.6938  0.8330  -0.8761   0.3882
## X1880.HK.Close          11.517   14.2268  3.7718  -0.5760  -0.7774
## X1898.HK.Close          10.447    4.6553  2.1576  -0.3712   0.1594
## X1928.HK.Close          18.833   37.9818  6.1629   0.3935  -0.8229
## X2318.HK.Close          65.959  167.7747 12.9528  -0.1478  -0.1610
## X2388.HK.Close          19.351   24.9852  4.9985  -0.5517  -0.0908
## X2600.HK.Close           6.545    3.4477  1.8568  -0.2542  -1.1001
## X2628.HK.Close          29.305   39.1300  6.2554  -0.2069  -1.2092
## X3328.HK.Close           7.546    2.4482  1.5647  -0.2664  -1.1503
## X3988.HK.Close           3.667    0.4836  0.6954  -0.6363  -0.4996
```

4.1 Higher Moments - Combined

```
##                 HSI Components to HSI Combined
## CoSkewness                              0.0000
## CoKurtosis                              0.0000
## Beta CoVariance                         0.0109
## Beta CoSkewness                         1.1758
## Beta CoKurtosis                        -0.0630
```

5 Principal Components Analysis

Principal components analysis, or PCA, seeks to find a set of orthogonal axes such that the first axis, or first principal component, accounts for as much variability as possible and subsequent axes are chosen to maximize variance while maintaining orthogonality with previous axes. Principal components are typically computed either by a singular value decomposition of the data matrix or an eigenvalue decomposition of a covariance or correlation matrix.[3] The calculation and chart below based on correlation. Future improvement here is to use sparse pca to reduce the number of important components to a more manageable number.[4] Principal component analysis (PCA) is an orthogonal transformation of possibly correlated variables into uncorrelated variables called principal components.

Terminology Factor loadings: The factor loadings, also called component loadings in PCA, are the correlation coefficients between the variables (rows) and factors (columns). Analogous to Pearson's r, the squared factor loading is the percent of variance in that indicator variable explained by the factor. To get the percent of variance in all the variables accounted for by each factor, add the sum of the squared factor loadings for that factor (column) and divide by the number of variables. (Note the number of variables equals the sum of their variances as the variance of a standardized variable is 1.) This is the same as dividing the factor's eigenvalue by the number of variables.

Interpreting factor loadings: By one rule of thumb in confirmatory factor analysis, loadings should be .7 or higher to confirm that independent variables identified a priori are represented by a particular factor, on the rationale that the .7 level corresponds to about half of the variance in the indicator being explained by the factor. However, the .7 standard is a high one and real-life data may well not meet this criterion, which is why some researchers, particularly for exploratory purposes, will use a lower level such as .4 for the central factor and .25 for other factors call loadings above .6 "high" and those below .4 "low". In any event, factor loadings must be interpreted in the light of theory, not by arbitrary cutoff levels.

In oblique rotation, one gets both a pattern matrix and a structure matrix. The structure matrix is simply the factor loading matrix as in orthogonal rotation, representing the variance in a measured variable explained by a factor on both a unique and common contributions basis. The pattern matrix, in contrast, contains coefficients which just represent unique contributions. The more factors, the lower the pattern coefficients as a rule since there will be more common contributions to variance explained. For oblique rotation, the researcher looks at both the structure and pattern coefficients when attributing a label to a factor.

Communality: The sum of the squared factor loadings for all factors for a given variable (row) is the variance in that variable accounted for by all the factors, and this is called the communality. The communality measures the percent of variance in a given variable explained by all the factors jointly and may be interpreted as the reliability of the indicator.

Spurious solutions: If the communality exceeds 1.0, there is a spurious solution, which may reflect too small a sample or the researcher has too many or too few factors.

Uniqueness of a variable: That is, uniqueness is the variability of a variable minus its communality.

Eigenvalues:/Characteristic roots: The eigenvalue for a given factor measures the variance in all the variables which is accounted for by that factor. The ratio of eigenvalues is the ratio of explanatory importance of the factors with respect to the variables. If a factor has a low eigenvalue, then it is contributing little to the explanation of variances in the variables and may be ignored as redundant with more important factors. Eigenvalues measure the amount of variation in the total sample accounted for by each factor.

Extraction sums of squared loadings: Initial eigenvalues and eigenvalues after extraction are the same for PCA extraction, but for other extraction methods, eigenvalues after extraction will be lower than their initial counterparts.

Factor scores (also called component scores in PCA): are the scores of each case (row) on each factor (column). To compute the factor score for a given case for a given factor, one takes the case's standardized score on each variable, multiplies by the corresponding factor loading of the variable for the given factor, and sums these products. Computing factor scores allows one to look for factor outliers. Also, factor scores may be used as variables in subsequent modeling.

Criteria for determining the number of factors Using one or more of the methods below, the researcher determines an appropriate range of solutions to investigate. Methods may not agree. For instance, the Kaiser criterion may suggest five factors and the scree test may suggest two, so the researcher may request 3-, 4-, and 5-factor solutions discuss each in terms of their relation to external data and theory.

Comprehensibility: A purely subjective criterion would be to retain those factors whose meaning is comprehensible to the researcher. This is not recommended.[5]

[3] http://blog.revolutionanalytics.com/2011/06/big-data-pca.html

[4] http://statmath.wu.ac.at/courses/optimization/Presentations/Nops+Thomas-sPCA1.pdf

[5] http://en.wikipedia.org/wiki/Factoranalysis

5.1 PCA with stats package princomp function

```
## Importance of components:
##                         Comp.1  Comp.2 Comp.3  Comp.4 Comp.5  Comp.6
## Standard deviation     5.0456 1.47468 1.2165 1.14279 1.0709 1.03167
## Proportion of Variance 0.5196 0.04438 0.0302 0.02665 0.0234 0.02172
## Cumulative Proportion  0.5196 0.56394 0.5941 0.62079 0.6442 0.66592
##                         Comp.7  Comp.8  Comp.9 Comp.10 Comp.11 Comp.12
## Standard deviation     0.96864 0.94397 0.91727 0.90478 0.85181 0.84438
## Proportion of Variance 0.01915 0.01819 0.01717 0.01671 0.01481 0.01455
## Cumulative Proportion  0.68507 0.70325 0.72042 0.73713 0.75194 0.76649
##                        Comp.13 Comp.14 Comp.15 Comp.16 Comp.17 Comp.18
## Standard deviation     0.82594 0.78745 0.77293 0.74196 0.73170 0.72150
## Proportion of Variance 0.01392 0.01265 0.01219 0.01123 0.01093 0.01062
## Cumulative Proportion  0.78041 0.79306 0.80526 0.81649 0.82742 0.83804
##                         Comp.19  Comp.20  Comp.21 Comp.22  Comp.23
## Standard deviation     0.692469 0.677455 0.659733 0.65141 0.631513
## Proportion of Variance 0.009786 0.009366 0.008883 0.00866 0.008139
## Cumulative Proportion  0.847826 0.857193 0.866075 0.87474 0.882874
##                         Comp.24  Comp.25  Comp.26  Comp.27  Comp.28
## Standard deviation     0.622296 0.608027 0.595814 0.592925 0.581662
## Proportion of Variance 0.007903 0.007545 0.007245 0.007175 0.006905
## Cumulative Proportion  0.890777 0.898322 0.905567 0.912742 0.919646
##                         Comp.29  Comp.30  Comp.31  Comp.32  Comp.33
## Standard deviation     0.563675 0.544274 0.531066 0.510997 0.502054
## Proportion of Variance 0.006484 0.006046 0.005756 0.005329 0.005144
## Cumulative Proportion  0.926131 0.932176 0.937932 0.943261 0.948405
##                         Comp.34  Comp.35  Comp.36  Comp.37  Comp.38
## Standard deviation     0.485521 0.477917 0.467833 0.453951 0.442275
## Proportion of Variance 0.004811 0.004661 0.004467 0.004206 0.003992
## Cumulative Proportion  0.953216 0.957877 0.962344 0.966549 0.970541
##                         Comp.39  Comp.40  Comp.41  Comp.42  Comp.43
## Standard deviation     0.427633 0.411837 0.395628 0.387456 0.374733
## Proportion of Variance 0.003732 0.003461 0.003194 0.003064 0.002866
## Cumulative Proportion  0.974273 0.977735 0.980929 0.983993 0.986859
##                         Comp.44 Comp.45  Comp.46  Comp.47  Comp.48
## Standard deviation     0.370224 0.36776 0.338178 0.312934 0.288924
## Proportion of Variance 0.002797 0.00276 0.002334 0.001999 0.001704
## Cumulative Proportion  0.989656 0.99242 0.994750 0.996748 0.998452
##                         Comp.49
## Standard deviation     0.275413
## Proportion of Variance 0.001548
## Cumulative Proportion  1.000000
##
## Loadings:
##         Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8 Comp.9
## 0001.HK -0.174         0.103 -0.179                -0.110
## 0002.HK        -0.472        -0.102  0.239  0.131  0.244        -0.106
## 0003.HK        -0.363        -0.281 -0.148 -0.104         0.230
## 0004.HK -0.163         0.113 -0.108
## 0005.HK -0.170
## 0006.HK        -0.478         0.152  0.213  0.117  0.324
## 0011.HK -0.155                -0.239  0.103                -0.141
## 0012.HK -0.157         0.161 -0.184                -0.105  0.219
## 0013.HK -0.168                -0.111         0.136                -0.139
## 0016.HK -0.153         0.206 -0.182                         0.224
## 0017.HK -0.139         0.214 -0.143                         0.212 -0.141
```

```
## 0019.HK -0.120               -0.212        -0.217 -0.187 -0.295 -0.432
## 0023.HK -0.148               -0.146  0.196               -0.262
## 0066.HK -0.134 -0.164        -0.163                      -0.213
## 0083.HK -0.153         0.172 -0.124         0.117         0.220
## 0101.HK -0.153         0.133                0.167
## 0144.HK -0.149                0.175         0.153  0.107        -0.140
## 0151.HK               -0.461 -0.114 -0.173 -0.273         0.301
## 0267.HK -0.157                                           -0.187 -0.102
## 0291.HK -0.122                               0.163  0.163  0.254 -0.103
## 0293.HK -0.126                               0.175        -0.225 -0.421
## 0322.HK               -0.483 -0.310  0.136         0.175         0.333
## 0330.HK                              -0.446 -0.134  0.631 -0.128
## 0386.HK -0.131 -0.225         0.302 -0.168        -0.306
## 0388.HK -0.168         0.106                -0.131
## 0494.HK -0.130                0.112        -0.184  0.121  0.106 -0.115
## 0688.HK -0.153  0.189         0.106  0.116         0.102         0.110
## 0700.HK -0.139                0.243  0.195  0.113               -0.121
## 0762.HK -0.129 -0.150 -0.211  0.197               -0.152  0.112
## 0836.HK               -0.136 -0.100 -0.547  0.457        -0.217  0.222
## 0857.HK -0.156 -0.138         0.184 -0.158        -0.162
## 0883.HK -0.170                0.155
## 0939.HK -0.171                                                    0.174
## 0941.HK -0.112 -0.324 -0.107        -0.122 -0.102 -0.117
## 1044.HK -0.110        -0.417                                0.169 -0.158
## 1088.HK -0.168
## 1109.HK -0.148  0.239
## 1199.HK -0.158                0.168         0.120  0.119
## 1299.HK -0.133                               0.334 -0.101         0.100
## 1398.HK -0.177                                                   -0.113  0.194
## 1880.HK -0.127        -0.180  0.144         0.155         0.167 -0.261
## 1898.HK -0.166                                      0.119 -0.162
## 1928.HK -0.140  0.138 -0.130         0.210  0.258
## 2318.HK -0.167                              -0.155
## 2388.HK -0.161                       0.178               -0.162
## 2600.HK -0.155                              -0.122  0.138
## 2628.HK -0.157                              -0.207                0.132
## 3328.HK -0.174                0.101                               0.110
## 3988.HK -0.169                              -0.139        -0.112  0.271
##         Comp.10 Comp.11 Comp.12 Comp.13 Comp.14 Comp.15 Comp.16 Comp.17
## 0001.HK                                                  0.118
## 0002.HK                  0.123           0.125          -0.249
## 0003.HK  0.118   0.270           0.219  -0.332  -0.154
## 0004.HK                  0.185                   0.120   0.134
## 0005.HK                 -0.100                   0.106
## 0006.HK -0.211  -0.300   0.117   0.153  -0.126           0.303   0.108
## 0011.HK  0.204           0.131
## 0012.HK                  0.123  -0.104
## 0013.HK                                                  0.160
## 0016.HK                                          0.140  -0.119
## 0017.HK         -0.254  -0.152   0.143   0.289
## 0019.HK -0.188                                  -0.236           0.339
## 0023.HK          0.186          -0.103  -0.115           0.133
## 0066.HK  0.198   0.140          -0.226   0.291   0.322   0.213
## 0083.HK -0.147                  -0.116   0.140                  -0.174
## 0101.HK  0.161                   0.139  -0.253
## 0144.HK  0.154  -0.152                   0.113  -0.113   0.101   0.196
## 0151.HK -0.174  -0.234   0.135   0.181                           -0.220
```

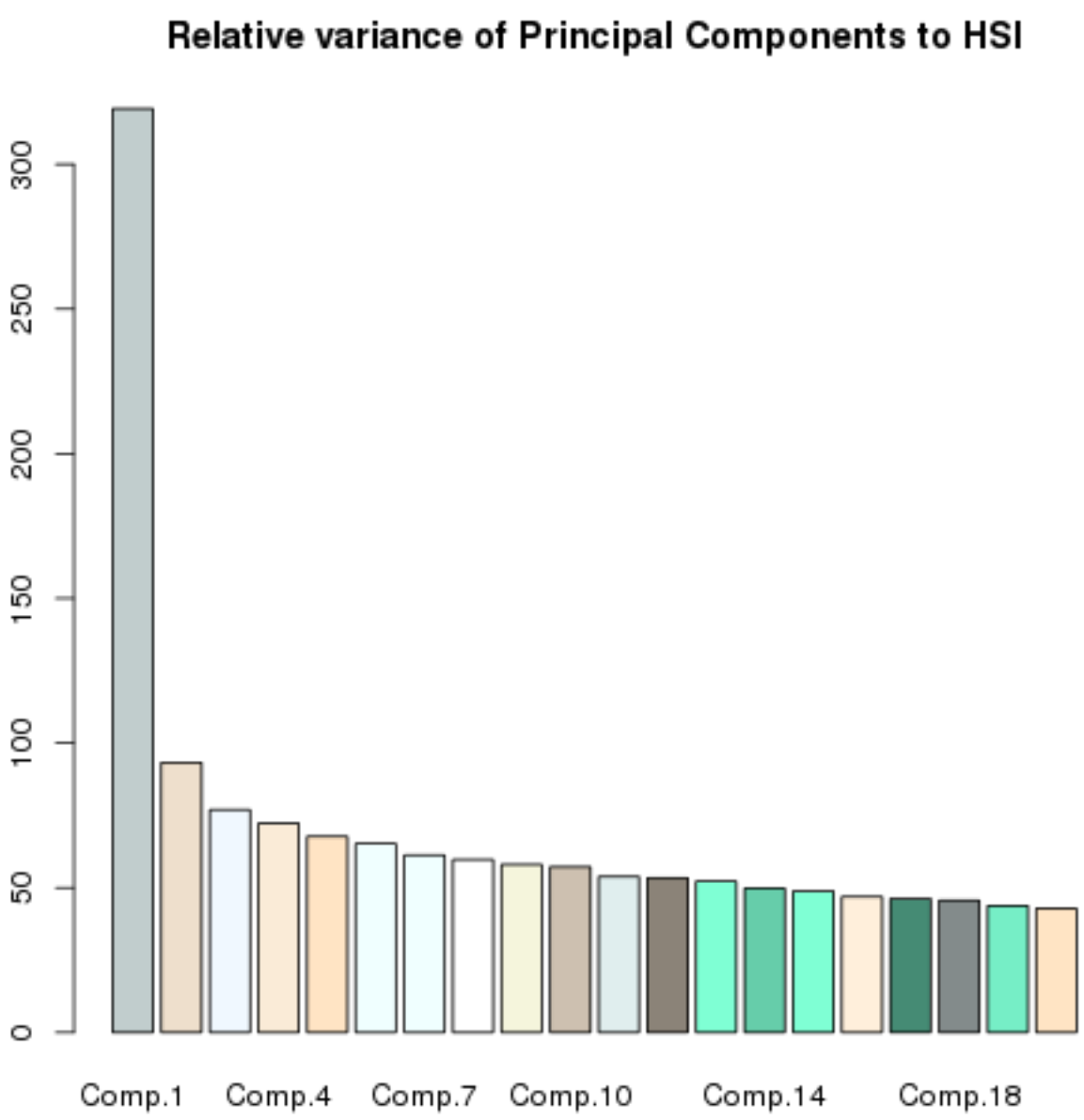
```
## 0267.HK                  0.123  -0.178   0.184                  0.184
## 0291.HK -0.238   0.210  -0.357  -0.520  -0.215  -0.190
## 0293.HK -0.198          -0.229          -0.330   0.258  -0.104  -0.257
## 0322.HK         -0.158  -0.223                   0.211  -0.254   0.371
## 0330.HK          0.236           0.174                  -0.221  -0.207
## 0386.HK                                                 -0.172
## 0388.HK
## 0494.HK  0.509  -0.191          -0.116  -0.352
## 0688.HK -0.190   0.244   0.215   0.127           0.120           0.106
## 0700.HK                                          0.312
## 0762.HK                  0.358  -0.195   0.124  -0.230  -0.352
## 0836.HK -0.167  -0.198   0.189                           0.184
## 0857.HK                                  -0.123   0.161  -0.239
## 0883.HK                                                 -0.213
## 0939.HK -0.107          -0.205           0.102  -0.155          -0.201
## 0941.HK -0.112   0.329  -0.189                   0.252   0.256
## 1044.HK  0.113           0.125  -0.179   0.138  -0.136   0.296  -0.214
## 1088.HK                  0.113          -0.115
## 1109.HK -0.192   0.203   0.300          -0.147                  0.125
## 1199.HK  0.134  -0.195  -0.186           0.150
## 1299.HK  0.271   0.215           0.218   0.268  -0.228           0.148
## 1398.HK                 -0.139                  -0.132          -0.117
## 1880.HK          0.268  -0.145   0.445   0.107                  0.119
## 1898.HK                                          -0.194
## 1928.HK                                  -0.106          -0.145  -0.132
## 2318.HK -0.123                                                   0.115
## 2388.HK                                                  -0.171  -0.129  -0.188
## 2600.HK -0.184                                                           0.226
## 2628.HK                                                   0.195           0.224
## 3328.HK                 -0.145                  -0.123   0.100  -0.173
## 3988.HK                 -0.177                  -0.177          -0.215
##         Comp.18 Comp.19 Comp.20 Comp.21 Comp.22 Comp.23 Comp.24 Comp.25
## 0001.HK                                  -0.130   0.118
## 0002.HK -0.102                  -0.195  -0.209  -0.165
## 0003.HK          0.411   0.219   0.113           0.129   0.150
## 0004.HK                         -0.103
## 0005.HK          0.194  -0.119   0.134          -0.108           0.155
## 0006.HK  0.113
## 0011.HK                                   0.112  -0.153  -0.241
## 0012.HK  0.125  -0.226   0.105  -0.140           0.116  -0.176
## 0013.HK                 -0.111                   0.154
## 0016.HK         -0.163           0.311           0.162
## 0017.HK                         -0.204  -0.230           0.319
## 0019.HK  0.135  -0.116           0.192   0.134  -0.163   0.139
## 0023.HK -0.219          -0.145   0.377                  -0.146   0.228
## 0066.HK                  0.324  -0.170   0.224
## 0083.HK  0.137                   0.270   0.207
## 0101.HK         -0.311  -0.168  -0.248          -0.220   0.183   0.274
## 0144.HK -0.280           0.240   0.134  -0.112   0.110           0.177
## 0151.HK -0.268                           0.175  -0.166
## 0267.HK          0.100                           0.327
## 0291.HK                 -0.148  -0.103   0.143  -0.199
## 0293.HK                  0.111          -0.291          -0.117  -0.317
## 0322.HK                 -0.108                   0.108
## 0330.HK  0.129          -0.217   0.122
## 0386.HK  0.250           0.169           0.143
## 0388.HK          0.177          -0.225          -0.108  -0.118  -0.161
```

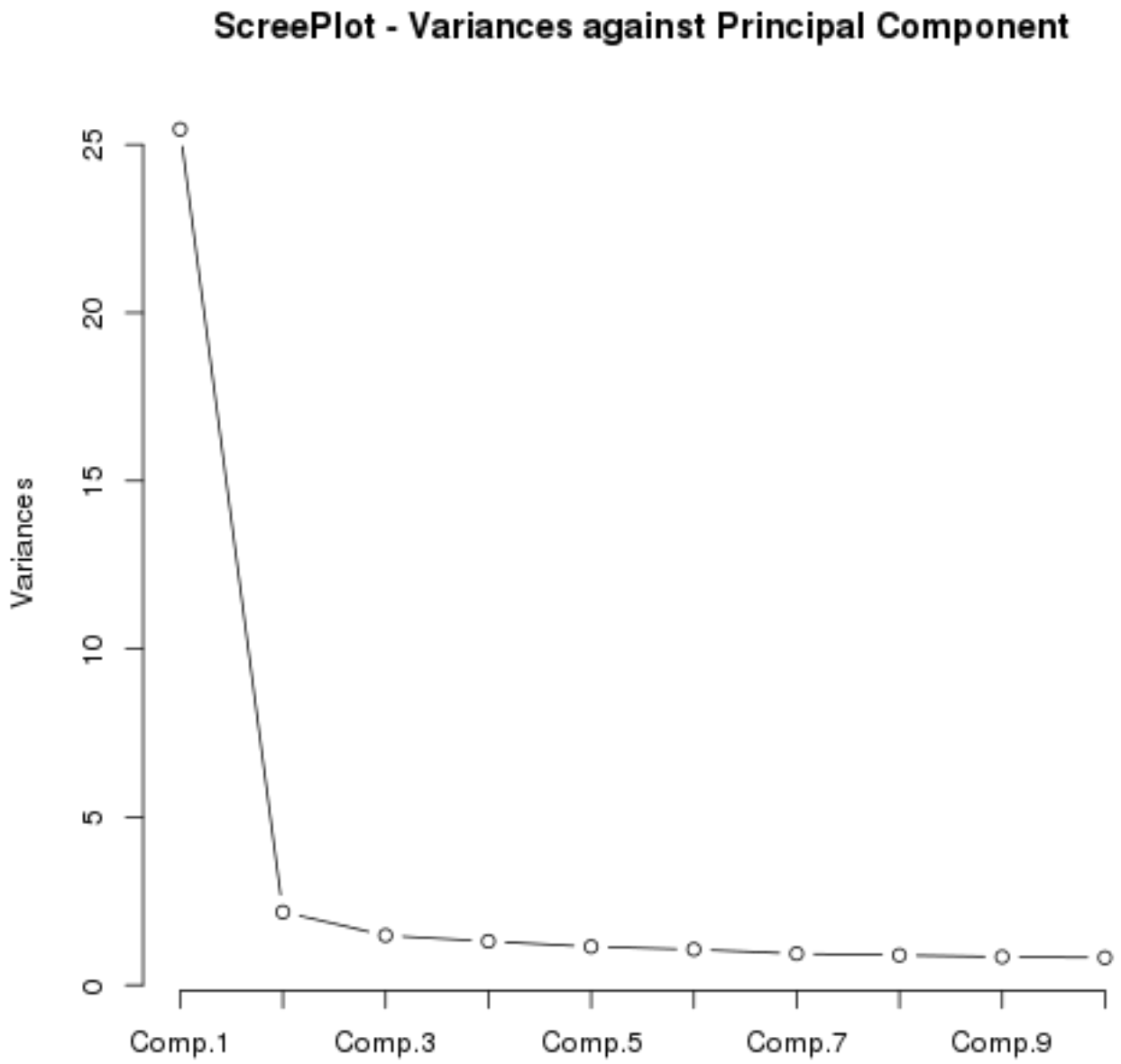
```
## 0494.HK         -0.267                                  0.111          -0.285
## 0688.HK                 0.158          -0.228          0.105
## 0700.HK -0.142   0.260  -0.364           0.336          0.150
## 0762.HK -0.194         -0.131  -0.125          0.145  -0.144  -0.220
## 0836.HK          0.152
## 0857.HK  0.169                         -0.119                  0.265
## 0883.HK          0.118          0.152  -0.103          -0.190   0.154
## 0939.HK                                                0.112  -0.109
## 0941.HK -0.138  -0.386  -0.193         -0.181   0.143   0.155
## 1044.HK  0.567   0.104                 -0.226  -0.140          0.151
## 1088.HK -0.196         -0.106                          0.129   0.258
## 1109.HK                 0.192         -0.277
## 1199.HK -0.140          0.133   0.286
## 1299.HK         -0.114  -0.109   0.162          -0.308          -0.450
## 1398.HK
## 1880.HK                         -0.260   0.142   0.196  -0.382   0.168
## 1898.HK                                                0.152
## 1928.HK                 0.229          0.279   0.238   0.524
## 2318.HK  0.143         -0.180                  0.219          -0.149
## 2388.HK -0.117   0.185          -0.183          0.138   0.157
## 2600.HK                 0.292          0.221  -0.329  -0.103
## 2628.HK  0.182   0.305  -0.220                 -0.106          -0.172
## 3328.HK                                 0.131
## 3988.HK
##         Comp.26 Comp.27 Comp.28 Comp.29 Comp.30 Comp.31 Comp.32 Comp.33
## 0001.HK                 0.124                  -0.107           0.130
## 0002.HK -0.180  -0.117                 -0.242          -0.276
## 0003.HK          0.220                 -0.167
## 0004.HK  0.219  -0.116   0.300         -0.242   0.133   0.206  -0.495
## 0005.HK         -0.267                          0.158           0.113
## 0006.HK         -0.116                  0.184  -0.178   0.201  -0.101
## 0011.HK  0.110                          0.511          -0.312
## 0012.HK                 -0.276   0.189  -0.180
## 0013.HK -0.135          0.197   0.214          -0.182   0.293   0.287
## 0016.HK -0.261          0.214           0.170   0.301  -0.199
## 0017.HK          0.209          -0.365   0.265           0.139
## 0019.HK -0.157  -0.101  -0.210         -0.103                  -0.145
## 0023.HK  0.200   0.116   0.141  -0.226          0.130   0.115
## 0066.HK -0.166  -0.164  -0.155  -0.174                  0.262
## 0083.HK  0.116         -0.282                  -0.136   0.128   0.157
## 0101.HK  0.152         -0.202  -0.145  -0.221                  0.102
## 0144.HK  0.162         -0.267   0.365
## 0151.HK         -0.184   0.148                  -0.248  -0.140
## 0267.HK  0.333   0.171                          -0.256  -0.296  -0.118
## 0291.HK -0.104                          0.147  -0.136          -0.226
## 0293.HK  0.200                                                  0.116
## 0322.HK          0.121          0.111                   0.222
## 0330.HK
## 0386.HK          0.138   0.115   0.140   0.281   0.155          -0.128
## 0388.HK                  0.128   0.158           0.176   0.137  -0.113
## 0494.HK -0.163         -0.118  -0.206
## 0688.HK -0.204                                  -0.117  -0.109
## 0700.HK -0.182   0.426  -0.180         -0.167
## 0762.HK  0.149                 -0.183          0.178   0.272
## 0836.HK -0.175                 -0.121          0.135  -0.112
## 0857.HK                 0.138                  -0.323   0.170
## 0883.HK                         -0.193  -0.182  -0.254          -0.159
```

```
## 0939.HK          0.101                                                  -0.146
## 0941.HK          0.158   0.125                          -0.103
## 1044.HK          0.161                          0.129
## 1088.HK         -0.197           0.362
## 1109.HK -0.181                           0.114           0.125
## 1199.HK         -0.118                  -0.201   0.270
## 1299.HK                                         -0.272
## 1398.HK                                                 -0.145  -0.133
## 1880.HK         -0.171          -0.205           0.150
## 1898.HK -0.227   0.142   0.299          -0.188  -0.180  -0.154   0.364
## 1928.HK  0.150  -0.233   0.141  -0.131           0.139
## 2318.HK  0.124  -0.164  -0.117   0.126                          -0.122
## 2388.HK -0.252                   0.176   0.190                  -0.142
## 2600.HK  0.134   0.298   0.260                                   0.259
## 2628.HK  0.247  -0.287                                  -0.230   0.286
## 3328.HK                                                         0.108
## 3988.HK                 -0.211
##         Comp.34 Comp.35 Comp.36 Comp.37 Comp.38 Comp.39 Comp.40 Comp.41
## 0001.HK  0.275                                                  -0.186
## 0002.HK          0.125  -0.140  -0.197          -0.204  -0.103  -0.118
## 0003.HK
## 0004.HK  0.239   0.144                  -0.138           0.216
## 0005.HK         -0.280   0.116           0.557  -0.173   0.359
## 0006.HK -0.131           0.138   0.164
## 0011.HK  0.173  -0.265                  -0.165           0.191
## 0012.HK                          0.462   0.192  -0.191   0.102   0.145
## 0013.HK                  0.273  -0.310          -0.124  -0.215  -0.124
## 0016.HK          0.102   0.185   0.150           0.256  -0.294
## 0017.HK          0.153                          -0.192
## 0019.HK                          -0.147                  0.123   0.140
## 0023.HK          0.220  -0.250           0.150  -0.103  -0.221
## 0066.HK          0.105   0.137   0.100
## 0083.HK -0.270           -0.357  -0.369  -0.224
## 0101.HK -0.186  -0.104   0.114                  0.385           -0.210
## 0144.HK  0.257   0.162  -0.195           0.186   0.308
## 0151.HK                                                         -0.105
## 0267.HK -0.289           0.222           0.150  -0.126          -0.178
## 0291.HK                                                         -0.101
## 0293.HK                          0.133
## 0322.HK
## 0330.HK  0.128
## 0386.HK          0.290          -0.136   0.165                  -0.254
## 0388.HK -0.422   0.115  -0.131  -0.180   0.187   0.187
## 0494.HK                 -0.130  -0.127          -0.296
## 0688.HK                          -0.155                  0.232  -0.184
## 0700.HK                          0.143                           0.109
## 0762.HK                  0.171                  0.221
## 0836.HK         -0.101  -0.142                                  0.155
## 0857.HK                 -0.158   0.157
## 0883.HK  0.152                   -0.196  -0.104          -0.140   0.272
## 0939.HK                  0.300  -0.194                          0.215
## 0941.HK         -0.274  -0.119                          0.101
## 1044.HK
## 1088.HK -0.238   0.203   0.227          -0.348  -0.314           0.165
## 1109.HK -0.190                                                  0.117
## 1199.HK -0.190  -0.273           0.147  -0.330                  -0.301
## 1299.HK                          0.166
```

```
## 1398.HK
## 1880.HK -0.107                                                -0.100
## 1898.HK          0.179                          0.216   0.403
## 1928.HK  0.116                          0.137                  0.161
## 2318.HK  0.180  -0.165  -0.177                 -0.131  -0.181  -0.395
## 2388.HK -0.154  -0.249  -0.346   0.218          0.211
## 2600.HK  0.142  -0.362                         -0.122  -0.190
## 2628.HK  0.114   0.141                          0.172  -0.158   0.260
## 3328.HK  0.152   0.167          0.167  -0.237          0.258  -0.281
## 3988.HK                  0.157                         -0.229
##         Comp.42 Comp.43 Comp.44 Comp.45 Comp.46 Comp.47 Comp.48 Comp.49
## 0001.HK  0.260  -0.242          0.312   0.324  -0.296   0.484
## 0002.HK         -0.105                 -0.120
## 0003.HK                        -0.118
## 0004.HK                 -0.216 -0.287
## 0005.HK                        -0.260
## 0006.HK
## 0011.HK -0.277           0.107   0.132
## 0012.HK -0.164   0.147  -0.166   0.210   0.133          -0.177
## 0013.HK -0.142          -0.239          -0.148   0.284  -0.227   0.129
## 0016.HK  0.117           0.167  -0.123  -0.229                  -0.105
## 0017.HK -0.106   0.147   0.109
## 0019.HK
## 0023.HK                                 0.226   0.107
## 0066.HK                  0.159  -0.164   0.108
## 0083.HK                        -0.187
## 0101.HK          0.104
## 0144.HK
## 0151.HK -0.144
## 0267.HK  0.158          -0.227          -0.118
## 0291.HK
## 0293.HK                        -0.163
## 0322.HK
## 0330.HK
## 0386.HK -0.112   0.174  -0.213           0.209
## 0388.HK                  0.271   0.481
## 0494.HK  0.129  -0.115
## 0688.HK  0.162                          0.160  -0.108  -0.550
## 0700.HK         -0.109
## 0762.HK                                                         0.129
## 0836.HK
## 0857.HK         -0.521   0.211   0.116  -0.130   0.105  -0.176
## 0883.HK  0.132   0.576           0.146                          -0.153
## 0939.HK         -0.255                  0.372   0.403          -0.371
## 0941.HK          0.107                 -0.149
## 1044.HK
## 1088.HK  0.185           0.258           0.158  -0.167
## 1109.HK -0.253                          -0.225   0.204   0.492
## 1199.HK -0.258          -0.164   0.158   0.203
## 1299.HK
## 1398.HK  0.183           0.124                  0.159           0.804
## 1880.HK         -0.138
## 1898.HK -0.318                 -0.204
## 1928.HK                         0.185          -0.105
## 2318.HK -0.201   0.170   0.469  -0.152                          -0.148
## 2388.HK  0.237          -0.262  -0.193   0.132
## 2600.HK  0.168                 -0.153
```

```
## 2628.HK                 -0.250           0.136                                  
## 3328.HK  0.340          -0.116   0.200  -0.440   0.240          -0.244          
## 3988.HK -0.259  -0.140  -0.204          -0.229  -0.627                          
##
##                Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8
## SS loadings      1.00  1.000  1.000  1.000  1.000  1.000  1.000  1.000
## Proportion Var   0.02  0.020  0.020  0.020  0.020  0.020  0.020  0.020
## Cumulative Var   0.02  0.041  0.061  0.082  0.102  0.122  0.143  0.163
##                Comp.9 Comp.10 Comp.11 Comp.12 Comp.13 Comp.14 Comp.15
## SS loadings     1.000   1.000   1.000   1.000   1.000   1.000   1.000
## Proportion Var  0.020   0.020   0.020   0.020   0.020   0.020   0.020
## Cumulative Var  0.184   0.204   0.224   0.245   0.265   0.286   0.306
##                Comp.16 Comp.17 Comp.18 Comp.19 Comp.20 Comp.21 Comp.22
## SS loadings      1.000   1.000   1.000   1.000   1.000   1.000   1.000
## Proportion Var   0.020   0.020   0.020   0.020   0.020   0.020   0.020
## Cumulative Var   0.327   0.347   0.367   0.388   0.408   0.429   0.449
##                Comp.23 Comp.24 Comp.25 Comp.26 Comp.27 Comp.28 Comp.29
## SS loadings      1.000    1.00    1.00   1.000   1.000   1.000   1.000
## Proportion Var   0.020    0.02    0.02   0.020   0.020   0.020   0.020
## Cumulative Var   0.469    0.49    0.51   0.531   0.551   0.571   0.592
##                Comp.30 Comp.31 Comp.32 Comp.33 Comp.34 Comp.35 Comp.36
## SS loadings      1.000   1.000   1.000   1.000   1.000   1.000   1.000
## Proportion Var   0.020   0.020   0.020   0.020   0.020   0.020   0.020
## Cumulative Var   0.612   0.633   0.653   0.673   0.694   0.714   0.735
##                Comp.37 Comp.38 Comp.39 Comp.40 Comp.41 Comp.42 Comp.43
## SS loadings      1.000   1.000   1.000   1.000   1.000   1.000   1.000
## Proportion Var   0.020   0.020   0.020   0.020   0.020   0.020   0.020
## Cumulative Var   0.755   0.776   0.796   0.816   0.837   0.857   0.878
##                Comp.44 Comp.45 Comp.46 Comp.47 Comp.48 Comp.49
## SS loadings      1.000   1.000   1.000   1.000    1.00    1.00
## Proportion Var   0.020   0.020   0.020   0.020    0.02    0.02
## Cumulative Var   0.898   0.918   0.939   0.959    0.98    1.00
```


Relative variance of Principal Components to HSI
0
50
100
150
200
250
300
Comp.1
Comp.4
Comp.7
Comp.10
Comp.14
Comp.18



The Cattell scree test plots the components as the X axis and the corresponding eigenvalues as the Y-axis. As one moves to the right, toward later components, the eigenvalues drop. When the drop ceases and the curve makes an elbow toward less steep decline, Cattell's scree test says to drop all further components after the one starting the elbow. This rule is sometimes criticised for being amenable to researcher-controlled "fudging". That is, as picking the "elbow" can be subjective because the curve has multiple elbows or is a smooth curve, the researcher may be tempted to set the cut-off at the number of factors desired by his or her research agenda.

5.2 PCA with psyche package principal Function

principal(...) Does an eigen value decomposition and returns eigen values, loadings, and degree of fit for a specified number of components. Basically it is just doing a principal components analysis (PCA) for n principal components of either a correlation or covariance matrix. Can show the residual correlations as well. The quality of reduction in the squared correlations is reported by comparing residual correlations to original correlations. Unlike princomp, this returns a subset of just the best nfactors. The eigen vectors are rescaled by the sqrt of the eigen values to produce the component loadings more typical in factor analysis.[6]

Rotation Methods[7] The unrotated output maximises the variance accounted for by the first and subsequent factors, and forcing the factors to be orthogonal. This data-compression comes at the cost of having most items load on the early factors, and usually, of having many items load substantially on more than one factor. Rotation serves to make the output more understandable, by seeking so-called "Simple Structure": A pattern of loadings where items load most strongly on one factor, and much more weakly on the other factors. Rotations can be orthogonal or oblique (allowing the factors to correlate).

[6] from psyche package help(principal)

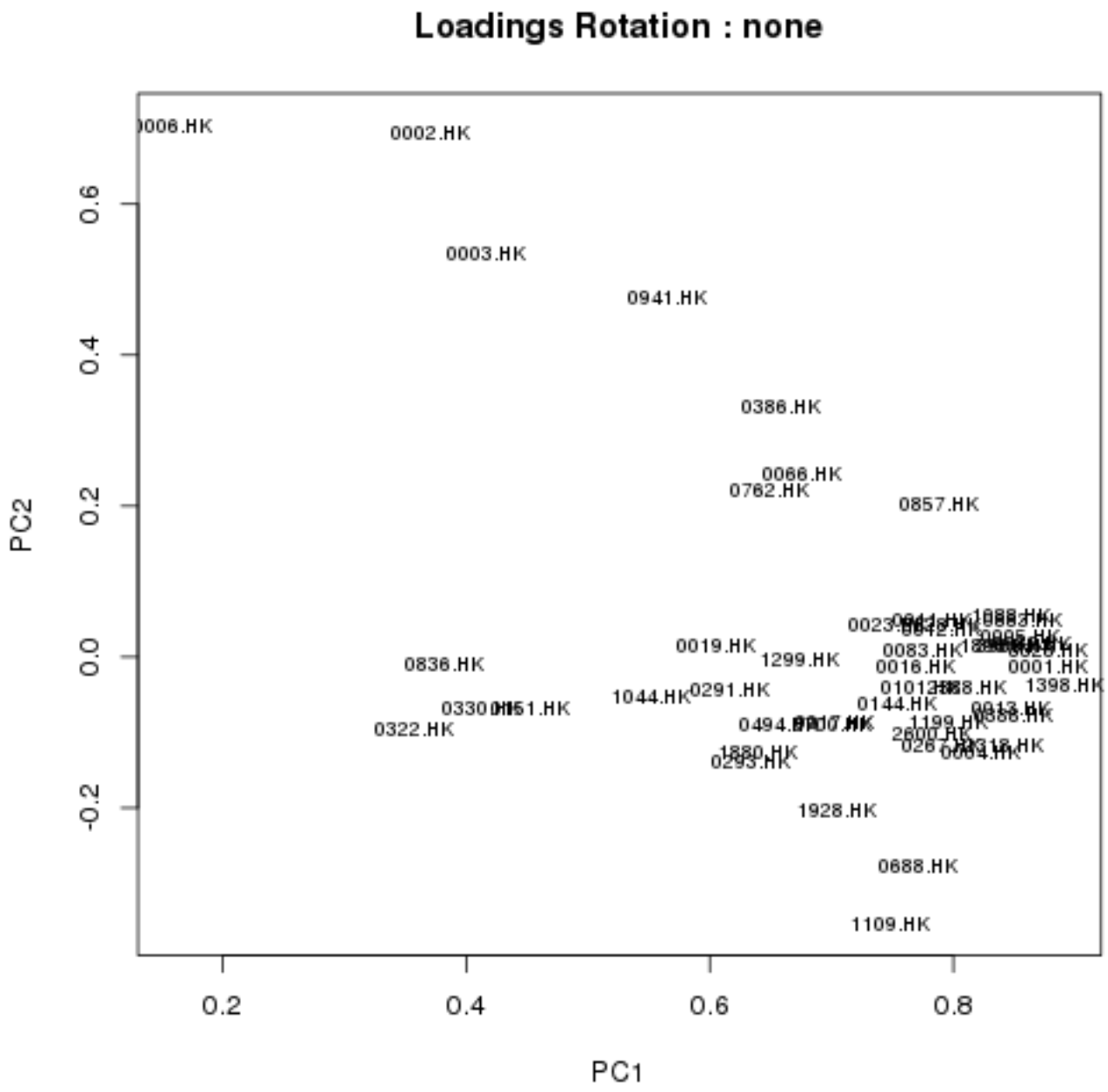
[7] http://en.wikipedia.org/wiki/Factoranalysis

5.2.1 Rotation : none

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "none")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         item  PC1   PC2   PC3   PC4   PC5   h2   u2
## 1398.HK   40 0.89 -0.04 -0.01 -0.07 -0.10 0.81 0.19
## 0001.HK    1 0.88 -0.01 -0.13  0.20  0.00 0.83 0.17
## 3328.HK   48 0.88  0.01 -0.01 -0.12  0.00 0.78 0.22
## 0939.HK   33 0.86  0.02  0.02 -0.05 -0.05 0.75 0.25
## 0883.HK   32 0.86  0.05  0.02 -0.18  0.00 0.77 0.23
## 0005.HK    5 0.86  0.03 -0.07 -0.05  0.02 0.74 0.26
## 3988.HK   49 0.85  0.02  0.01 -0.03 -0.02 0.73 0.27
## 0388.HK   25 0.85 -0.08 -0.13  0.11  0.00 0.76 0.24
## 1088.HK   36 0.85  0.05  0.06 -0.11  0.05 0.74 0.26
## 0013.HK    9 0.85 -0.07 -0.08  0.13  0.04 0.75 0.25
## 2318.HK   44 0.84 -0.12 -0.10 -0.07 -0.07 0.74 0.26
## 1898.HK   42 0.84  0.01 -0.02 -0.09  0.00 0.71 0.29
## 0004.HK    4 0.82 -0.13 -0.14  0.12 -0.02 0.73 0.27
## 2388.HK   45 0.81 -0.04  0.00  0.08 -0.19 0.70 0.30
## 1199.HK   38 0.80 -0.09 -0.09 -0.19  0.06 0.69 0.31
## 0267.HK   19 0.79 -0.12  0.03  0.11  0.10 0.66 0.34
## 0012.HK    8 0.79  0.04 -0.20  0.21  0.03 0.71 0.29
## 2628.HK   47 0.79  0.04 -0.07 -0.09  0.01 0.64 0.36
## 0857.HK   31 0.79  0.20  0.01 -0.21  0.17 0.74 0.26
## 0011.HK    7 0.78  0.05 -0.02  0.27 -0.11 0.70 0.30
## 2600.HK   46 0.78 -0.10 -0.08 -0.11 -0.05 0.64 0.36
## 0083.HK   15 0.77  0.01 -0.21  0.14 -0.02 0.66 0.34
## 0101.HK   16 0.77 -0.04 -0.16  0.07  0.03 0.63 0.37
## 0688.HK   27 0.77 -0.28 -0.06 -0.12 -0.12 0.71 0.29
## 0016.HK   10 0.77 -0.01 -0.25  0.21 -0.05 0.70 0.30
## 0144.HK   17 0.75 -0.06  0.05 -0.20  0.10 0.62 0.38
## 1109.HK   37 0.75 -0.35 -0.05 -0.09 -0.05 0.70 0.30
## 0023.HK   13 0.75  0.04  0.11  0.17 -0.21 0.64 0.36
## 1928.HK   43 0.70 -0.20  0.16 -0.04 -0.23 0.61 0.39
## 0017.HK   11 0.70 -0.09 -0.26  0.16  0.08 0.60 0.40
## 0700.HK   28 0.70 -0.09  0.06 -0.28 -0.21 0.62 0.38
## 0066.HK   14 0.68  0.24  0.05  0.19  0.09 0.56 0.44
## 1299.HK   39 0.67  0.00  0.05  0.09 -0.05 0.47 0.53
## 0386.HK   24 0.66  0.33 -0.02 -0.34  0.18 0.70 0.30
## 0494.HK   26 0.66 -0.09  0.02 -0.13  0.04 0.46 0.54
## 0762.HK   29 0.65  0.22  0.26 -0.22  0.00 0.59 0.41
## 1880.HK   41 0.64 -0.13  0.22 -0.16 -0.07 0.50 0.50
## 0293.HK   21 0.63 -0.14  0.03  0.06  0.00 0.43 0.57
## 0291.HK   20 0.62 -0.04  0.02  0.02  0.06 0.39 0.61
## 0019.HK   12 0.61  0.02  0.05  0.24  0.08 0.43 0.57
## 0941.HK   34 0.56  0.48  0.13 -0.10  0.13 0.59 0.41
## 1044.HK   35 0.55 -0.05  0.51 -0.03 -0.09 0.58 0.42
## 0006.HK    6 0.16  0.70 -0.06 -0.17 -0.23 0.61 0.39
## 0002.HK    2 0.37  0.70  0.02  0.12 -0.26 0.70 0.30
## 0003.HK    3 0.42  0.54 -0.03  0.32  0.16 0.59 0.41
## 0322.HK   22 0.36 -0.10  0.59  0.35 -0.15 0.63 0.37
## 0151.HK   18 0.45 -0.07  0.56  0.13  0.18 0.57 0.43
## 0836.HK   30 0.38 -0.01  0.16  0.11  0.59 0.53 0.47
## 0330.HK   23 0.41 -0.07 -0.03 -0.08  0.48 0.41 0.59
##
##                  PC1  PC2  PC3  PC4  PC5
```

```
## SS loadings    25.46 2.17 1.48 1.31 1.15
## Proportion Var  0.52 0.04 0.03 0.03 0.02
## Cumulative Var  0.52 0.56 0.59 0.62 0.64
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1176  and the objective function was  45.55 0.3
## The degrees of freedom for the model are 941  and the objective function was  7.59
##  0.3The number of observations was  247  with Chi Square =  1711  with prob <  2.3e-47
##  0.3
## Fit based upon off diagonal values = 1
##            PC1       PC2
## 0001.HK 0.8785 -0.012960
## 0002.HK 0.3712  0.695992
## 0003.HK 0.4156  0.535601
## 0004.HK 0.8218 -0.126325
## 0005.HK 0.8559  0.026195
## 0006.HK 0.1598  0.704352
## 0011.HK 0.7836  0.049945
## 0012.HK 0.7909  0.036330
## 0013.HK 0.8476 -0.067005
## 0016.HK 0.7700 -0.013762
## 0017.HK 0.7024 -0.085769
## 0019.HK 0.6062  0.016616
## 0023.HK 0.7466  0.042775
## 0066.HK 0.6761  0.242387
## 0083.HK 0.7744  0.009434
## 0101.HK 0.7728 -0.039901
## 0144.HK 0.7535 -0.062064
## 0151.HK 0.4529 -0.066561
## 0267.HK 0.7910 -0.117605
## 0291.HK 0.6173 -0.044731
## 0293.HK 0.6337 -0.139784
## 0322.HK 0.3580 -0.096491
## 0330.HK 0.4120 -0.068686
## 0386.HK 0.6596  0.331474
## 0388.HK 0.8496 -0.076439
## 0494.HK 0.6565 -0.088138
## 0688.HK 0.7719 -0.278334
## 0700.HK 0.7006 -0.089133
## 0762.HK 0.6501  0.221615
## 0836.HK 0.3818 -0.008703
## 0857.HK 0.7885  0.203216
## 0883.HK 0.8573  0.048258
## 0939.HK 0.8649  0.017445
## 0941.HK 0.5644  0.477273
## 1044.HK 0.5527 -0.053668
## 1088.HK 0.8485  0.053691
## 1109.HK 0.7483 -0.353147
## 1199.HK 0.7962 -0.085744
## 1299.HK 0.6735 -0.002122
## 1398.HK 0.8921 -0.037434
## 1880.HK 0.6392 -0.126222
## 1898.HK 0.8385  0.014543
## 1928.HK 0.7039 -0.202970
## 2318.HK 0.8425 -0.117312
## 2388.HK 0.8108 -0.040207
```

```
## 2600.HK 0.7819 -0.102598
## 2628.HK 0.7901  0.042349
## 3328.HK 0.8771  0.008538
## 3988.HK 0.8520  0.016275
```



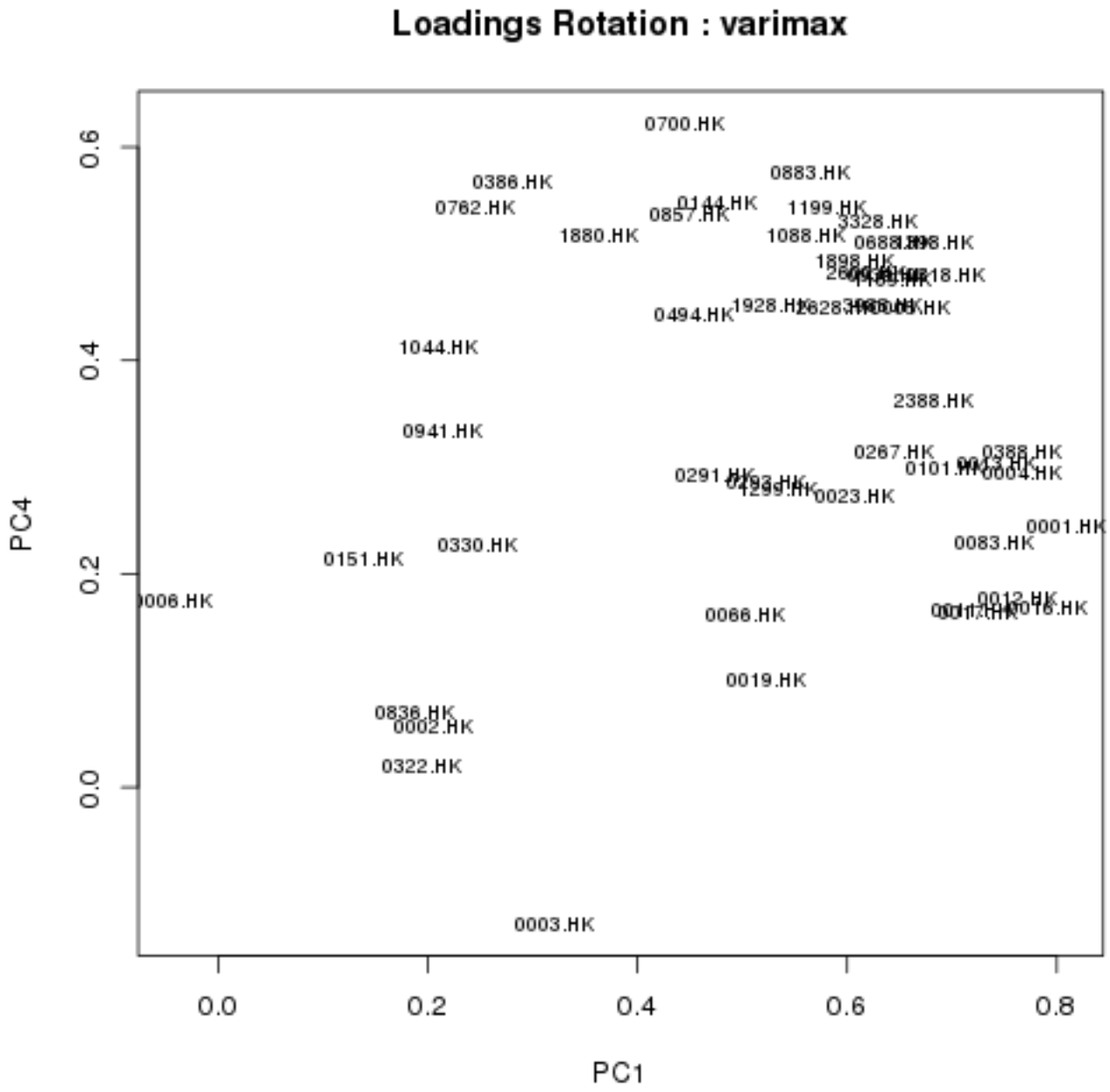
5.2.2 Rotation : varimax

Varimax rotation is an orthogonal rotation of the factor axes to maximize the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix, which has the effect of differentiating the original variables by extracted factor. Each factor will tend to have either large or small loadings of any particular variable. A varimax solution yields results which make it as easy as possible to identify each variable with a single factor. This is the most common rotation option.

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "varimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         item   PC1   PC4   PC2   PC3   PC5   h2   u2
## 0001.HK    1  0.81  0.24  0.20  0.19  0.19 0.83 0.17
## 0016.HK   10  0.79  0.17  0.18  0.06  0.10 0.70 0.30
## 0004.HK    4  0.77  0.29  0.08  0.15  0.14 0.73 0.27
## 0388.HK   25  0.77  0.31  0.13  0.15  0.17 0.76 0.24
## 0012.HK    8  0.76  0.18  0.23  0.10  0.19 0.71 0.29
## 0013.HK    9  0.74  0.30  0.13  0.19  0.22 0.75 0.25
## 0083.HK   15  0.74  0.23  0.20  0.07  0.14 0.66 0.34
## 0017.HK   11  0.72  0.16  0.08  0.01  0.21 0.60 0.40
## 0011.HK    7  0.72  0.17  0.26  0.29  0.08 0.70 0.30
## 0101.HK   16  0.69  0.30  0.14  0.08  0.18 0.63 0.37
## 2318.HK   44  0.69  0.48  0.08  0.12  0.10 0.74 0.26
## 1398.HK   40  0.68  0.51  0.18  0.21  0.09 0.81 0.19
## 2388.HK   45  0.68  0.36  0.18  0.27 -0.01 0.70 0.30
## 0005.HK    5  0.66  0.45  0.22  0.13  0.20 0.74 0.26
## 0267.HK   19  0.65  0.31  0.07  0.26  0.27 0.66 0.34
## 0688.HK   27  0.65  0.51 -0.08  0.15  0.02 0.71 0.29
## 1109.HK   37  0.64  0.48 -0.17  0.16  0.09 0.70 0.30
## 0939.HK   33  0.64  0.48  0.22  0.22  0.14 0.75 0.25
## 3988.HK   49  0.63  0.45  0.21  0.21  0.17 0.73 0.27
## 3328.HK   48  0.63  0.53  0.20  0.17  0.19 0.78 0.22
## 2600.HK   46  0.62  0.48  0.08  0.10  0.11 0.64 0.36
## 1898.HK   42  0.61  0.49  0.20  0.16  0.18 0.71 0.29
## 0023.HK   13  0.61  0.27  0.25  0.37 -0.02 0.64 0.36
## 2628.HK   47  0.59  0.45  0.22  0.09  0.18 0.64 0.36
## 1199.HK   38  0.58  0.54  0.08  0.05  0.21 0.69 0.31
## 1088.HK   36  0.56  0.52  0.24  0.21  0.24 0.74 0.26
## 1299.HK   39  0.53  0.28  0.17  0.26  0.10 0.47 0.53
## 1928.HK   43  0.53  0.45 -0.01  0.36 -0.06 0.61 0.39
## 0293.HK   21  0.52  0.29  0.02  0.23  0.13 0.43 0.57
## 0019.HK   12  0.52  0.10  0.16  0.27  0.22 0.43 0.57
## 0066.HK   14  0.50  0.16  0.39  0.25  0.26 0.56 0.44
## 0291.HK   20  0.47  0.29  0.09  0.18  0.19 0.39 0.61
## 0494.HK   26  0.45  0.44  0.06  0.14  0.18 0.46 0.54
## 0700.HK   28  0.45  0.62  0.09  0.17 -0.06 0.62 0.38
## 0883.HK   32  0.57  0.58  0.24  0.16  0.18 0.77 0.23
## 0386.HK   24  0.28  0.57  0.43 -0.04  0.33 0.70 0.30
## 0144.HK   17  0.48  0.55  0.09  0.15  0.26 0.62 0.38
## 0762.HK   29  0.25  0.54  0.35  0.28  0.17 0.59 0.41
## 0857.HK   31  0.45  0.54  0.35  0.08  0.34 0.74 0.26
## 1880.HK   41  0.36  0.52  0.03  0.31  0.08 0.50 0.50
## 0002.HK    2  0.20  0.06  0.79  0.11 -0.12 0.70 0.30
## 0006.HK    6 -0.04  0.18  0.73 -0.12 -0.16 0.61 0.39
## 0003.HK    3  0.32 -0.13  0.61  0.12  0.28 0.59 0.41
## 0941.HK   34  0.21  0.33  0.57  0.15  0.29 0.59 0.41
## 0322.HK   22  0.19  0.02  0.03  0.77 -0.01 0.63 0.37
## 0151.HK   18  0.14  0.21  0.03  0.63  0.33 0.57 0.43
```

```
## 1044.HK   35  0.21  0.41  0.09  0.59  0.07 0.58 0.42
## 0836.HK   30  0.19  0.07  0.02  0.20  0.67 0.53 0.47
## 0330.HK   23  0.25  0.23 -0.03 -0.02  0.54 0.41 0.59
##
##                  PC1  PC4  PC2  PC3  PC5
## SS loadings    15.49 7.35 3.41 2.98 2.34
## Proportion Var  0.32 0.15 0.07 0.06 0.05
## Cumulative Var  0.32 0.47 0.54 0.60 0.64
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1176  and the objective function was  45.55 0.3
## The degrees of freedom for the model are 941  and the objective function was  7.59
##  0.3The number of observations was  247  with Chi Square =  1711  with prob <  2.3e-47
##  0.3
## Fit based upon off diagonal values = 1
##             PC1      PC4
## 0001.HK  0.8101  0.24498
## 0002.HK  0.2045  0.05753
## 0003.HK  0.3212 -0.12792
## 0004.HK  0.7679  0.29442
## 0005.HK  0.6599  0.44862
## 0006.HK -0.0422  0.17552
## 0011.HK  0.7188  0.16698
## 0012.HK  0.7626  0.17648
## 0013.HK  0.7418  0.30419
## 0016.HK  0.7912  0.16873
## 0017.HK  0.7240  0.16365
## 0019.HK  0.5238  0.10121
## 0023.HK  0.6067  0.27233
## 0066.HK  0.5023  0.16247
## 0083.HK  0.7407  0.22915
## 0101.HK  0.6943  0.29815
## 0144.HK  0.4761  0.54877
## 0151.HK  0.1390  0.21438
## 0267.HK  0.6458  0.31379
## 0291.HK  0.4738  0.29365
## 0293.HK  0.5238  0.28656
## 0322.HK  0.1936  0.02015
## 0330.HK  0.2474  0.22800
## 0386.HK  0.2812  0.56738
## 0388.HK  0.7671  0.31404
## 0494.HK  0.4549  0.44299
## 0688.HK  0.6452  0.51133
## 0700.HK  0.4453  0.62238
## 0762.HK  0.2465  0.54341
## 0836.HK  0.1877  0.06994
## 0857.HK  0.4500  0.53713
## 0883.HK  0.5658  0.57669
## 0939.HK  0.6373  0.47931
## 0941.HK  0.2149  0.33324
## 1044.HK  0.2103  0.41359
## 1088.HK  0.5609  0.51833
## 1109.HK  0.6418  0.47668
## 1199.HK  0.5817  0.54277
## 1299.HK  0.5333  0.27967
## 1398.HK  0.6835  0.51124
```

```
## 1880.HK  0.3638  0.51708
## 1898.HK  0.6082  0.49325
## 1928.HK  0.5282  0.45224
## 2318.HK  0.6930  0.48005
## 2388.HK  0.6833  0.36234
## 2600.HK  0.6187  0.48288
## 2628.HK  0.5905  0.45058
## 3328.HK  0.6284  0.53130
## 3988.HK  0.6348  0.45248
```



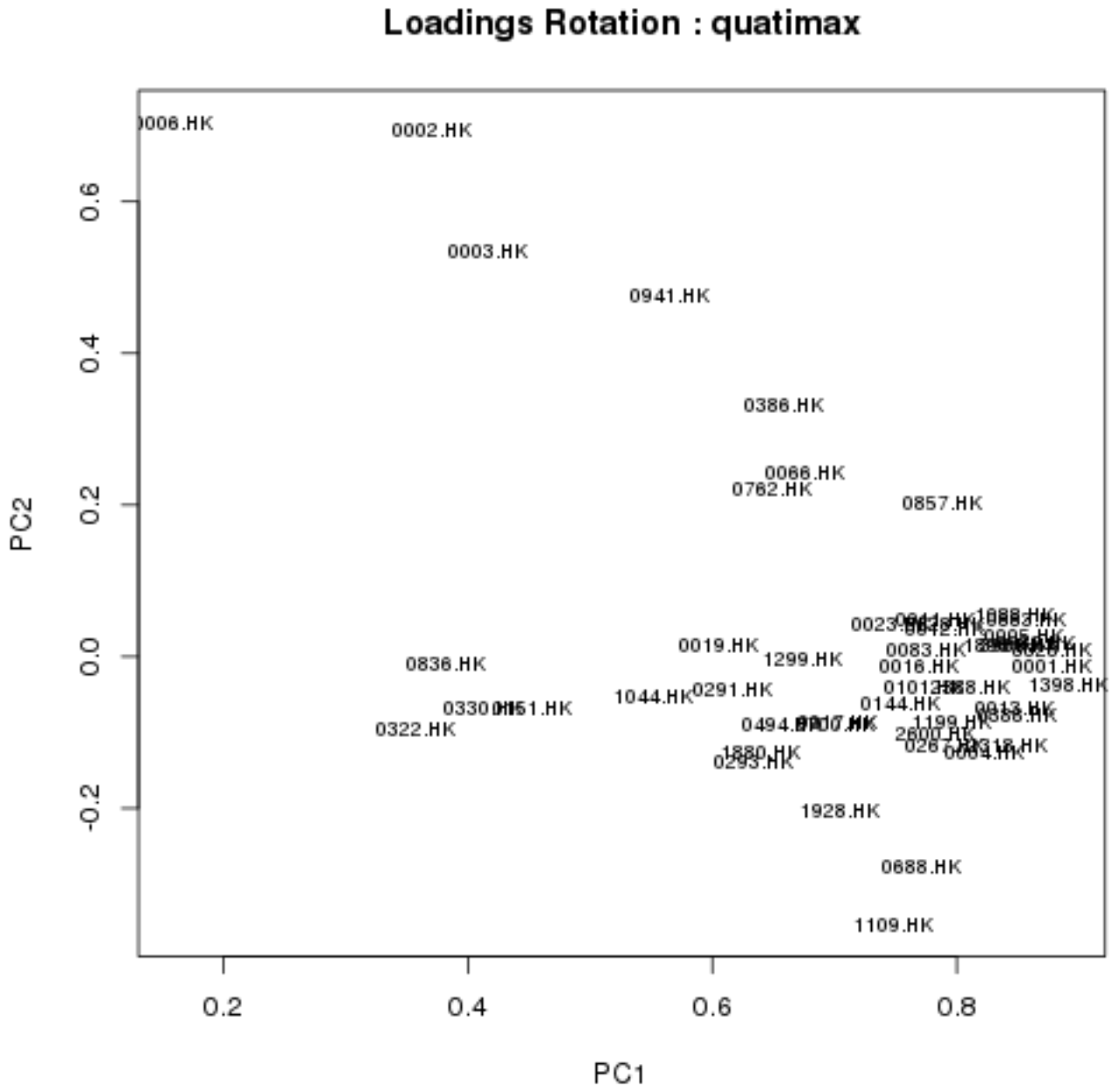
5.2.3 Rotation : quatimax

Quartimax rotation is an orthogonal alternative which minimizes the number of factors needed to explain each variable. This type of rotation often generates a general factor on which most variables are loaded to a high or medium degree. Such a factor structure is usually not helpful to the research purpose.

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "quatimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         item  PC1   PC2   PC3   PC4   PC5   h2   u2
## 1398.HK   40 0.89 -0.04 -0.01 -0.07 -0.10 0.81 0.19
## 0001.HK    1 0.88 -0.01 -0.13  0.20  0.00 0.83 0.17
## 3328.HK   48 0.88  0.01 -0.01 -0.12  0.00 0.78 0.22
## 0939.HK   33 0.86  0.02  0.02 -0.05 -0.05 0.75 0.25
## 0883.HK   32 0.86  0.05  0.02 -0.18  0.00 0.77 0.23
## 0005.HK    5 0.86  0.03 -0.07 -0.05  0.02 0.74 0.26
## 3988.HK   49 0.85  0.02  0.01 -0.03 -0.02 0.73 0.27
## 0388.HK   25 0.85 -0.08 -0.13  0.11  0.00 0.76 0.24
## 1088.HK   36 0.85  0.05  0.06 -0.11  0.05 0.74 0.26
## 0013.HK    9 0.85 -0.07 -0.08  0.13  0.04 0.75 0.25
## 2318.HK   44 0.84 -0.12 -0.10 -0.07 -0.07 0.74 0.26
## 1898.HK   42 0.84  0.01 -0.02 -0.09  0.00 0.71 0.29
## 0004.HK    4 0.82 -0.13 -0.14  0.12 -0.02 0.73 0.27
## 2388.HK   45 0.81 -0.04  0.00  0.08 -0.19 0.70 0.30
## 1199.HK   38 0.80 -0.09 -0.09 -0.19  0.06 0.69 0.31
## 0267.HK   19 0.79 -0.12  0.03  0.11  0.10 0.66 0.34
## 0012.HK    8 0.79  0.04 -0.20  0.21  0.03 0.71 0.29
## 2628.HK   47 0.79  0.04 -0.07 -0.09  0.01 0.64 0.36
## 0857.HK   31 0.79  0.20  0.01 -0.21  0.17 0.74 0.26
## 0011.HK    7 0.78  0.05 -0.02  0.27 -0.11 0.70 0.30
## 2600.HK   46 0.78 -0.10 -0.08 -0.11 -0.05 0.64 0.36
## 0083.HK   15 0.77  0.01 -0.21  0.14 -0.02 0.66 0.34
## 0101.HK   16 0.77 -0.04 -0.16  0.07  0.03 0.63 0.37
## 0688.HK   27 0.77 -0.28 -0.06 -0.12 -0.12 0.71 0.29
## 0016.HK   10 0.77 -0.01 -0.25  0.21 -0.05 0.70 0.30
## 0144.HK   17 0.75 -0.06  0.05 -0.20  0.10 0.62 0.38
## 1109.HK   37 0.75 -0.35 -0.05 -0.09 -0.05 0.70 0.30
## 0023.HK   13 0.75  0.04  0.11  0.17 -0.21 0.64 0.36
## 1928.HK   43 0.70 -0.20  0.16 -0.04 -0.23 0.61 0.39
## 0017.HK   11 0.70 -0.09 -0.26  0.16  0.08 0.60 0.40
## 0700.HK   28 0.70 -0.09  0.06 -0.28 -0.21 0.62 0.38
## 0066.HK   14 0.68  0.24  0.05  0.19  0.09 0.56 0.44
## 1299.HK   39 0.67  0.00  0.05  0.09 -0.05 0.47 0.53
## 0386.HK   24 0.66  0.33 -0.02 -0.34  0.18 0.70 0.30
## 0494.HK   26 0.66 -0.09  0.02 -0.13  0.04 0.46 0.54
## 0762.HK   29 0.65  0.22  0.26 -0.22  0.00 0.59 0.41
## 1880.HK   41 0.64 -0.13  0.22 -0.16 -0.07 0.50 0.50
## 0293.HK   21 0.63 -0.14  0.03  0.06  0.00 0.43 0.57
## 0291.HK   20 0.62 -0.04  0.02  0.02  0.06 0.39 0.61
## 0019.HK   12 0.61  0.02  0.05  0.24  0.08 0.43 0.57
## 0941.HK   34 0.56  0.48  0.13 -0.10  0.13 0.59 0.41
## 1044.HK   35 0.55 -0.05  0.51 -0.03 -0.09 0.58 0.42
## 0006.HK    6 0.16  0.70 -0.06 -0.17 -0.23 0.61 0.39
## 0002.HK    2 0.37  0.70  0.02  0.12 -0.26 0.70 0.30
## 0003.HK    3 0.42  0.54 -0.03  0.32  0.16 0.59 0.41
## 0322.HK   22 0.36 -0.10  0.59  0.35 -0.15 0.63 0.37
## 0151.HK   18 0.45 -0.07  0.56  0.13  0.18 0.57 0.43
## 0836.HK   30 0.38 -0.01  0.16  0.11  0.59 0.53 0.47
```

```
## 0330.HK   23 0.41 -0.07 -0.03 -0.08  0.48 0.41 0.59
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    25.46 2.17 1.48 1.31 1.15
## Proportion Var  0.52 0.04 0.03 0.03 0.02
## Cumulative Var  0.52 0.56 0.59 0.62 0.64
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1176  and the objective function was  45.55 0.3
## The degrees of freedom for the model are 941  and the objective function was  7.59
##  0.3The number of observations was  247  with Chi Square =  1711  with prob <  2.3e-47
##  0.3
## Fit based upon off diagonal values = 1
##            PC1       PC2
## 0001.HK 0.8785 -0.012960
## 0002.HK 0.3712  0.695992
## 0003.HK 0.4156  0.535601
## 0004.HK 0.8218 -0.126325
## 0005.HK 0.8559  0.026195
## 0006.HK 0.1598  0.704352
## 0011.HK 0.7836  0.049945
## 0012.HK 0.7909  0.036330
## 0013.HK 0.8476 -0.067005
## 0016.HK 0.7700 -0.013762
## 0017.HK 0.7024 -0.085769
## 0019.HK 0.6062  0.016616
## 0023.HK 0.7466  0.042775
## 0066.HK 0.6761  0.242387
## 0083.HK 0.7744  0.009434
## 0101.HK 0.7728 -0.039901
## 0144.HK 0.7535 -0.062064
## 0151.HK 0.4529 -0.066561
## 0267.HK 0.7910 -0.117605
## 0291.HK 0.6173 -0.044731
## 0293.HK 0.6337 -0.139784
## 0322.HK 0.3580 -0.096491
## 0330.HK 0.4120 -0.068686
## 0386.HK 0.6596  0.331474
## 0388.HK 0.8496 -0.076439
## 0494.HK 0.6565 -0.088138
## 0688.HK 0.7719 -0.278334
## 0700.HK 0.7006 -0.089133
## 0762.HK 0.6501  0.221615
## 0836.HK 0.3818 -0.008703
## 0857.HK 0.7885  0.203216
## 0883.HK 0.8573  0.048258
## 0939.HK 0.8649  0.017445
## 0941.HK 0.5644  0.477273
## 1044.HK 0.5527 -0.053668
## 1088.HK 0.8485  0.053691
## 1109.HK 0.7483 -0.353147
## 1199.HK 0.7962 -0.085744
## 1299.HK 0.6735 -0.002122
## 1398.HK 0.8921 -0.037434
## 1880.HK 0.6392 -0.126222
## 1898.HK 0.8385  0.014543
```

```
## 1928.HK 0.7039 -0.202970
## 2318.HK 0.8425 -0.117312
## 2388.HK 0.8108 -0.040207
## 2600.HK 0.7819 -0.102598
## 2628.HK 0.7901  0.042349
## 3328.HK 0.8771  0.008538
## 3988.HK 0.8520  0.016275
```



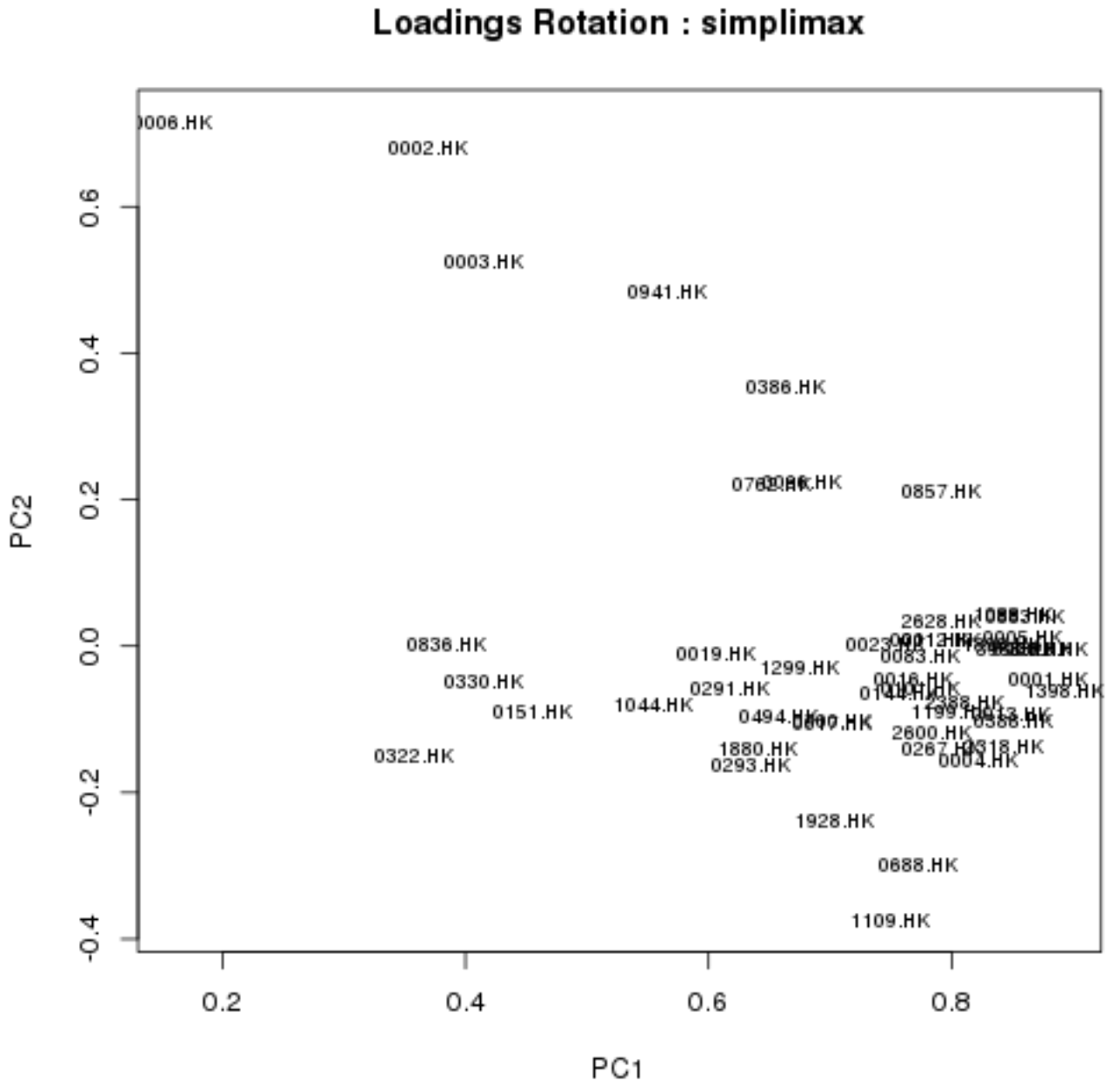
5.2.4 Rotation : simplimax

A compromise between Varimax and Quartimax criteria.

```
## Warning message: convergence not obtained in GPFoblq. 1000 iterations used.
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "simplimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         item  PC1   PC2   PC4   PC3   PC5   h2   u2
## 1398.HK   40 0.89 -0.06 -0.01 -0.01 -0.09 0.81 0.19
## 3328.HK   48 0.88  0.00 -0.06 -0.01  0.00 0.78 0.22
## 0001.HK    1 0.88 -0.05  0.28 -0.17  0.00 0.83 0.17
## 0939.HK   33 0.87  0.00  0.00  0.02 -0.05 0.75 0.25
## 0883.HK   32 0.86  0.04 -0.13  0.04 -0.01 0.77 0.23
## 0005.HK    5 0.86  0.01  0.01 -0.08  0.01 0.74 0.26
## 3988.HK   49 0.85  0.00  0.02  0.00 -0.01 0.73 0.27
## 1088.HK   36 0.85  0.04 -0.06  0.06  0.05 0.74 0.26
## 0388.HK   25 0.85 -0.10  0.19 -0.16  0.00 0.76 0.24
## 0013.HK    9 0.85 -0.09  0.20 -0.12  0.05 0.75 0.25
## 2318.HK   44 0.84 -0.14 -0.01 -0.09 -0.06 0.74 0.26
## 1898.HK   42 0.84  0.00 -0.04 -0.02  0.00 0.71 0.29
## 0004.HK    4 0.82 -0.16  0.20 -0.17 -0.01 0.73 0.27
## 2388.HK   45 0.81 -0.08  0.12  0.00 -0.17 0.70 0.30
## 1199.HK   38 0.80 -0.09 -0.12 -0.07  0.06 0.69 0.31
## 0267.HK   19 0.79 -0.14  0.19  0.00  0.13 0.66 0.34
## 2628.HK   47 0.79  0.03 -0.04 -0.08  0.00 0.64 0.36
## 0857.HK   31 0.79  0.21 -0.17  0.01  0.13 0.74 0.26
## 0012.HK    8 0.79  0.01  0.27 -0.24  0.00 0.71 0.29
## 2600.HK   46 0.78 -0.12 -0.05 -0.07 -0.04 0.64 0.36
## 0011.HK    7 0.78  0.01  0.32 -0.06 -0.10 0.70 0.30
## 0083.HK   15 0.77 -0.01  0.20 -0.24 -0.04 0.66 0.34
## 0101.HK   16 0.77 -0.06  0.14 -0.19  0.02 0.63 0.37
## 0688.HK   27 0.77 -0.30 -0.05 -0.03 -0.08 0.71 0.29
## 0016.HK   10 0.77 -0.04  0.27 -0.29 -0.08 0.70 0.30
## 0144.HK   17 0.76 -0.06 -0.14  0.06  0.12 0.62 0.38
## 1109.HK   37 0.75 -0.37  0.00 -0.04  0.01 0.70 0.30
## 0023.HK   13 0.75  0.00  0.20  0.09 -0.18 0.64 0.36
## 1928.HK   43 0.70 -0.24  0.01  0.18 -0.15 0.61 0.39
## 0017.HK   11 0.70 -0.11  0.24 -0.30  0.06 0.60 0.40
## 0700.HK   28 0.70 -0.10 -0.25  0.12 -0.18 0.62 0.38
## 0066.HK   14 0.68  0.22  0.22  0.00  0.07 0.56 0.44
## 1299.HK   39 0.67 -0.03  0.13  0.03 -0.03 0.47 0.53
## 0386.HK   24 0.66  0.36 -0.33  0.00  0.11 0.70 0.30
## 0494.HK   26 0.66 -0.10 -0.07  0.03  0.06 0.46 0.54
## 0762.HK   29 0.65  0.22 -0.22  0.28  0.00 0.59 0.41
## 1880.HK   41 0.64 -0.14 -0.12  0.25 -0.01 0.50 0.50
## 0293.HK   21 0.63 -0.16  0.12  0.02  0.04 0.43 0.57
## 0291.HK   20 0.62 -0.06  0.07  0.00  0.07 0.39 0.61
## 0019.HK   12 0.61 -0.01  0.30 -0.01  0.10 0.43 0.57
## 0941.HK   34 0.57  0.48 -0.11  0.11  0.07 0.59 0.41
## 1044.HK   35 0.55 -0.08  0.00  0.52  0.01 0.58 0.42
## 0006.HK    6 0.16  0.72 -0.28 -0.03 -0.37 0.61 0.39
## 0002.HK    2 0.37  0.68  0.03  0.00 -0.37 0.70 0.30
## 0003.HK    3 0.42  0.52  0.31 -0.12  0.07 0.59 0.41
## 0322.HK   22 0.36 -0.15  0.38  0.55  0.00 0.63 0.37
## 0151.HK   18 0.45 -0.09  0.18  0.52  0.30 0.57 0.43
## 0836.HK   30 0.38  0.00  0.20  0.09  0.62 0.53 0.47
## 0330.HK   23 0.42 -0.05  0.00 -0.07  0.48 0.41 0.59
```

```
##
##                  PC1  PC2  PC4  PC3  PC5
## SS loadings    25.45 2.17 1.31 1.48 1.16
## Proportion Var  0.52 0.04 0.03 0.03 0.02
## Cumulative Var  0.52 0.56 0.59 0.62 0.64
##
##  With component correlations of
##       PC1  PC2   PC4   PC3   PC5
## PC1  1.00 0.01 -0.06  0.00  0.00
## PC2  0.01 1.00  0.17  0.06  0.10
## PC4 -0.06 0.17  1.00  0.19 -0.15
## PC3  0.00 0.06  0.19  1.00 -0.11
## PC5  0.00 0.10 -0.15 -0.11  1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1176  and the objective function was  45.55 0.3
## The degrees of freedom for the model are 941  and the objective function was  7.59
##  0.3The number of observations was  247  with Chi Square =  1711  with prob <  2.3e-47
##  0.3
## Fit based upon off diagonal values = 1
##            PC1       PC2
## 0001.HK 0.8789 -0.045217
## 0002.HK 0.3702  0.679772
## 0003.HK 0.4154  0.524541
## 0004.HK 0.8224 -0.155160
## 0005.HK 0.8578  0.012002
## 0006.HK 0.1599  0.715699
## 0011.HK 0.7830  0.008616
## 0012.HK 0.7910  0.009535
## 0013.HK 0.8486 -0.093215
## 0016.HK 0.7697 -0.043941
## 0017.HK 0.7027 -0.105484
## 0019.HK 0.6065 -0.010659
## 0023.HK 0.7464  0.001233
## 0066.HK 0.6770  0.222721
## 0083.HK 0.7747 -0.015000
## 0101.HK 0.7738 -0.059110
## 0144.HK 0.7566 -0.063932
## 0151.HK 0.4550 -0.089062
## 0267.HK 0.7925 -0.141528
## 0291.HK 0.6186 -0.059301
## 0293.HK 0.6346 -0.162645
## 0322.HK 0.3572 -0.150292
## 0330.HK 0.4154 -0.048495
## 0386.HK 0.6636  0.355237
## 0388.HK 0.8504 -0.103273
## 0494.HK 0.6587 -0.095638
## 0688.HK 0.7733 -0.300069
## 0700.HK 0.7026 -0.101857
## 0762.HK 0.6530  0.220265
## 0836.HK 0.3850  0.002085
## 0857.HK 0.7920  0.211224
## 0883.HK 0.8600  0.039628
## 0939.HK 0.8666 -0.003076
## 0941.HK 0.5669  0.484157
## 1044.HK 0.5544 -0.081462
```

```
## 1088.HK 0.8510  0.043142
## 1109.HK 0.7498 -0.374059
## 1199.HK 0.7989 -0.089040
## 1299.HK 0.6742 -0.028008
## 1398.HK 0.8937 -0.060332
## 1880.HK 0.6414 -0.141549
## 1898.HK 0.8406  0.001213
## 1928.HK 0.7047 -0.236891
## 2318.HK 0.8440 -0.136569
## 2388.HK 0.8111 -0.075982
## 2600.HK 0.7837 -0.116931
## 2628.HK 0.7920  0.032462
## 3328.HK 0.8795 -0.004400
## 3988.HK 0.8538 -0.003168
```



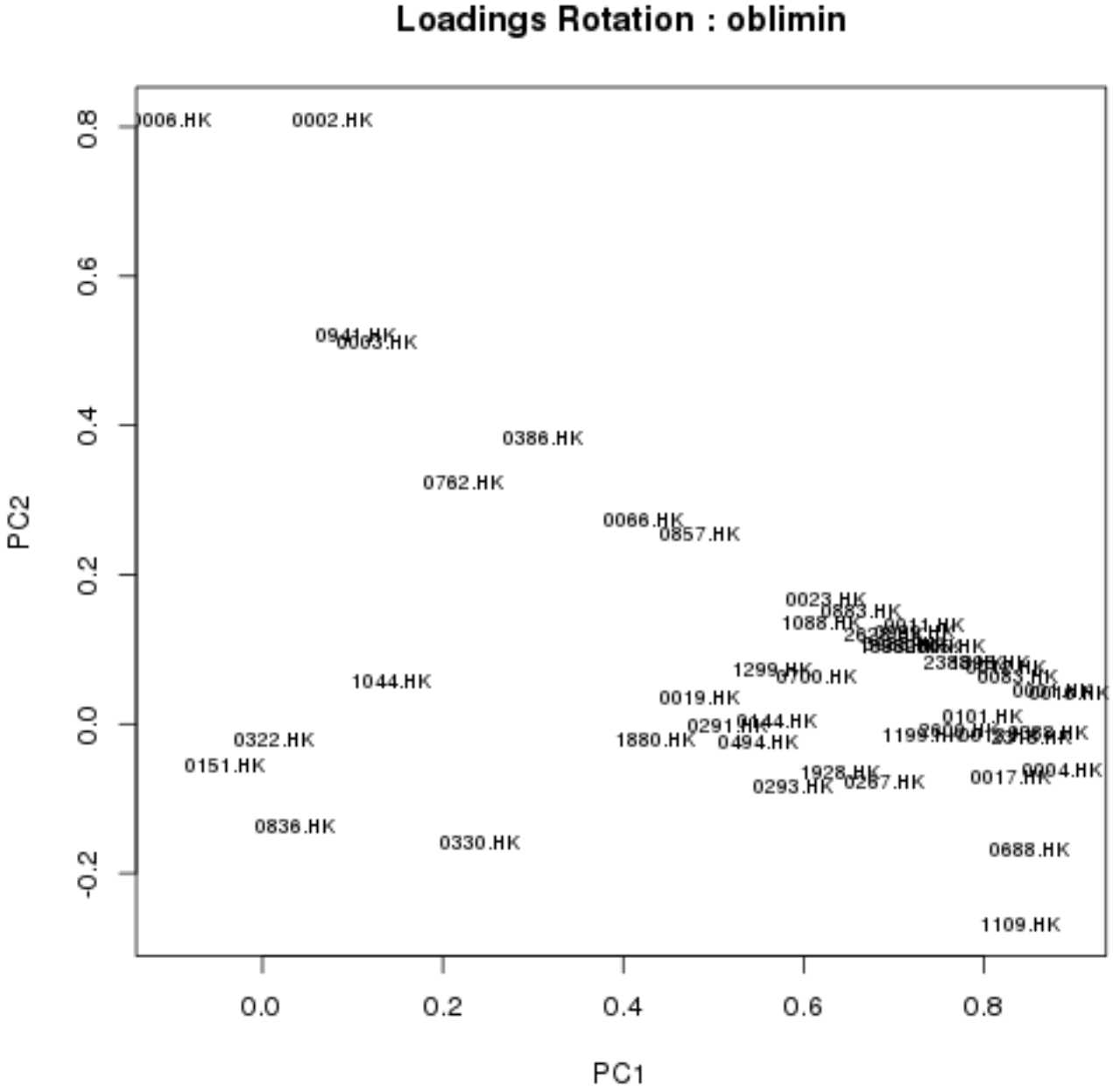
5.2.5 Rotation : oblimin

Direct oblimin rotation is the standard method when one wishes a non-orthogonal (oblique) solution – that is, one in which the factors are allowed to be correlated. This will result in higher eigenvalues but diminished interpretability of the factors.

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "oblimin")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         item   PC1   PC2   PC3   PC5   PC4   h2   u2
## 0016.HK   10  0.90  0.04 -0.10 -0.05 -0.21 0.70 0.30
## 0004.HK    4  0.89 -0.06  0.00  0.00 -0.09 0.73 0.27
## 0001.HK    1  0.88  0.05  0.03  0.04 -0.18 0.83 0.17
## 0388.HK   25  0.87 -0.01  0.00  0.03 -0.09 0.76 0.24
## 2318.HK   44  0.85 -0.02 -0.02 -0.01  0.11 0.74 0.26
## 0688.HK   27  0.85 -0.17  0.02 -0.10  0.19 0.71 0.29
## 1109.HK   37  0.84 -0.27  0.03 -0.04  0.16 0.70 0.30
## 0083.HK   15  0.84  0.06 -0.09  0.01 -0.15 0.66 0.34
## 0017.HK   11  0.83 -0.07 -0.15  0.08 -0.19 0.60 0.40
## 0012.HK    8  0.83  0.08 -0.05  0.05 -0.22 0.71 0.29
## 0013.HK    9  0.82 -0.01  0.05  0.09 -0.10 0.75 0.25
## 1398.HK   40  0.81  0.08  0.08 -0.02  0.13 0.81 0.19
## 0101.HK   16  0.80  0.01 -0.06  0.06 -0.07 0.63 0.37
## 2388.HK   45  0.78  0.08  0.14 -0.14  0.00 0.70 0.30
## 2600.HK   46  0.77 -0.01 -0.02  0.01  0.15 0.64 0.36
## 0005.HK    5  0.76  0.10  0.00  0.11  0.07 0.74 0.26
## 0011.HK    7  0.73  0.13  0.17 -0.07 -0.21 0.70 0.30
## 3328.HK   48  0.73  0.10  0.05  0.10  0.15 0.78 0.22
## 1199.HK   38  0.73 -0.01 -0.06  0.14  0.21 0.69 0.31
## 0939.HK   33  0.72  0.12  0.11  0.04  0.10 0.75 0.25
## 3988.HK   49  0.71  0.11  0.10  0.07  0.08 0.73 0.27
## 1898.HK   42  0.70  0.10  0.05  0.09  0.13 0.71 0.29
## 0267.HK   19  0.69 -0.08  0.15  0.15 -0.06 0.66 0.34
## 2628.HK   47  0.69  0.12 -0.02  0.10  0.10 0.64 0.36
## 0883.HK   32  0.66  0.15  0.06  0.12  0.22 0.77 0.23
## 1928.HK   43  0.64 -0.06  0.27 -0.17  0.17 0.61 0.39
## 0023.HK   13  0.63  0.17  0.27 -0.15 -0.07 0.64 0.36
## 1088.HK   36  0.62  0.14  0.11  0.17  0.15 0.74 0.26
## 0700.HK   28  0.61  0.06  0.08 -0.12  0.36 0.62 0.38
## 0293.HK   21  0.59 -0.08  0.14  0.03  0.00 0.43 0.57
## 0144.HK   17  0.57  0.00  0.07  0.20  0.24 0.62 0.38
## 1299.HK   39  0.56  0.07  0.17  0.01 -0.03 0.47 0.53
## 0494.HK   26  0.55 -0.02  0.06  0.11  0.17 0.46 0.54
## 0291.HK   20  0.52  0.00  0.09  0.11  0.01 0.39 0.61
## 0019.HK   12  0.48  0.04  0.19  0.12 -0.20 0.43 0.57
## 0857.HK   31  0.48  0.26  0.00  0.32  0.20 0.74 0.26
## 1880.HK   41  0.44 -0.02  0.27  0.02  0.27 0.50 0.50
## 0066.HK   14  0.42  0.27  0.17  0.19 -0.17 0.56 0.44
## 0006.HK    6 -0.10  0.81 -0.13 -0.09  0.13 0.61 0.39
## 0002.HK    2  0.08  0.81  0.08 -0.13 -0.12 0.70 0.30
## 0941.HK   34  0.10  0.52  0.13  0.31  0.08 0.59 0.41
## 0003.HK    3  0.13  0.51  0.06  0.25 -0.38 0.59 0.41
## 0386.HK   24  0.31  0.38 -0.10  0.36  0.30 0.70 0.30
## 0762.HK   29  0.22  0.32  0.26  0.18  0.29 0.59 0.41
## 0322.HK   22  0.01 -0.02  0.80 -0.09 -0.15 0.63 0.37
## 0151.HK   18 -0.04 -0.05  0.68  0.30  0.01 0.57 0.43
## 1044.HK   35  0.14  0.06  0.61  0.03  0.20 0.58 0.42
## 0836.HK   30  0.04 -0.14  0.20  0.67 -0.14 0.53 0.47
```

```
## 0330.HK   23  0.24 -0.16 -0.06  0.54  0.02 0.41 0.59
##
##                  PC1  PC2  PC3  PC5  PC4
## SS loadings    21.58 3.08 2.93 2.36 1.62
## Proportion Var  0.44 0.06 0.06 0.05 0.03
## Cumulative Var  0.44 0.50 0.56 0.61 0.64
##
##  With component correlations of
##      PC1  PC2  PC3  PC5  PC4
## PC1 1.00 0.34 0.46 0.41 0.18
## PC2 0.34 1.00 0.15 0.21 0.02
## PC3 0.46 0.15 1.00 0.17 0.10
## PC5 0.41 0.21 0.17 1.00 0.08
## PC4 0.18 0.02 0.10 0.08 1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1176  and the objective function was  45.55 0.3
## The degrees of freedom for the model are 941  and the objective function was  7.59
##  0.3The number of observations was  247  with Chi Square =  1711  with prob <  2.3e-47
##  0.3
## Fit based upon off diagonal values = 1
##              PC1       PC2
## 0001.HK  0.87677  0.045781
## 0002.HK  0.07823  0.808168
## 0003.HK  0.12776  0.512042
## 0004.HK  0.88554 -0.062201
## 0005.HK  0.75652  0.103666
## 0006.HK -0.10002  0.810034
## 0011.HK  0.73410  0.132099
## 0012.HK  0.82527  0.076435
## 0013.HK  0.81650 -0.014100
## 0016.HK  0.89557  0.041609
## 0017.HK  0.82956 -0.072243
## 0019.HK  0.48448  0.035868
## 0023.HK  0.62555  0.166075
## 0066.HK  0.42236  0.273222
## 0083.HK  0.83711  0.064682
## 0101.HK  0.79746  0.011087
## 0144.HK  0.57112  0.003188
## 0151.HK -0.04100 -0.054393
## 0267.HK  0.69025 -0.077724
## 0291.HK  0.51673 -0.001773
## 0293.HK  0.58909 -0.083497
## 0322.HK  0.01193 -0.020829
## 0330.HK  0.24072 -0.157254
## 0386.HK  0.31127  0.382253
## 0388.HK  0.87149 -0.012274
## 0494.HK  0.54909 -0.024419
## 0688.HK  0.84949 -0.167082
## 0700.HK  0.61355  0.063949
## 0762.HK  0.22357  0.324256
## 0836.HK  0.03617 -0.135589
## 0857.HK  0.48444  0.256366
## 0883.HK  0.66361  0.151026
## 0939.HK  0.72234  0.122000
## 0941.HK  0.10430  0.521710
```

```
## 1044.HK  0.14177  0.057325
## 1088.HK  0.62005  0.136904
## 1109.HK  0.84036 -0.267819
## 1199.HK  0.73190 -0.014544
## 1299.HK  0.56425  0.073176
## 1398.HK  0.80742  0.081354
## 1880.HK  0.43606 -0.019463
## 1898.HK  0.70405  0.103989
## 1928.HK  0.64122 -0.063665
## 2318.HK  0.85401 -0.018740
## 2388.HK  0.77762  0.083871
## 2600.HK  0.77242 -0.009735
## 2628.HK  0.68938  0.119853
## 3328.HK  0.73231  0.103052
## 3988.HK  0.71131  0.107896
```


Loadings Rotation : oblimin
PC2
PC1
0.8
0.6
0.4
0.2
0.0
-0.2
0.0
0.2
0.4
0.6
0.8
0006.HK
0002.HK
0003.HK
0386.HK
0762.HK
0066.HK
0857.HK
1088.HK
1044.HK
0700.HK
0019.HK
0322.HK
0151.HK
1880.HK
0494.HK
0836.HK
0330.HK
0293.HK
0017.HK
0688.HK
1109.HK

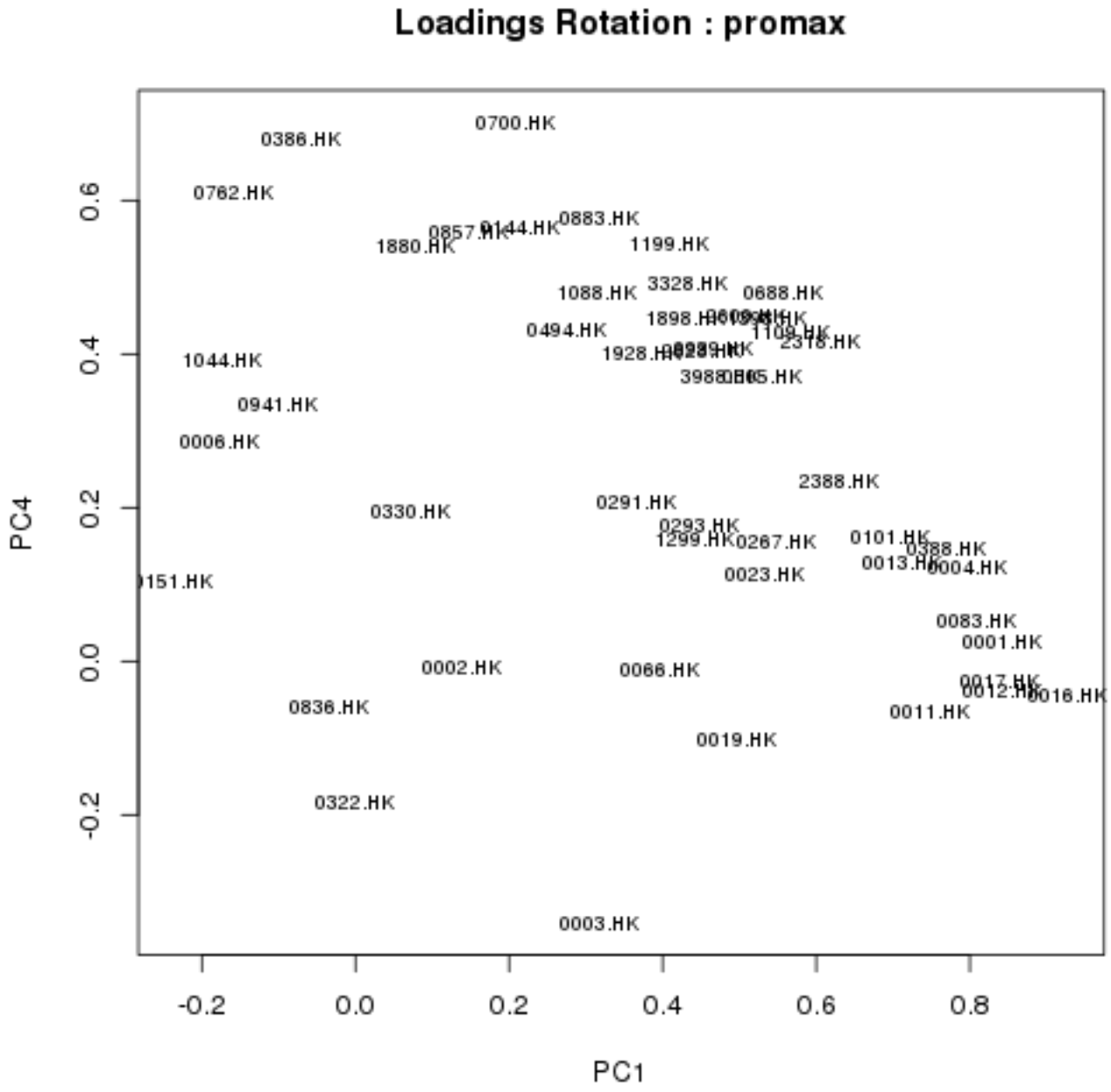
5.2.6 Rotation : promax

Promax rotation is an alternative non-orthogonal (oblique) rotation method which is computationally faster than the direct oblimin method and therefore is sometimes used for very large datasets.

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "promax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##         item   PC1   PC4   PC2   PC3   PC5   h2   u2
## 0016.HK   10  0.93 -0.04  0.06 -0.12 -0.05 0.70 0.30
## 0012.HK    8  0.84 -0.04  0.08 -0.07  0.05 0.71 0.29
## 0001.HK    1  0.84  0.03  0.05  0.02  0.04 0.83 0.17
## 0017.HK   11  0.84 -0.03 -0.08 -0.17  0.10 0.60 0.40
## 0083.HK   15  0.81  0.05  0.07 -0.11 -0.01 0.66 0.34
## 0004.HK    4  0.80  0.12 -0.07 -0.02  0.00 0.73 0.27
## 0388.HK   25  0.77  0.15 -0.03 -0.03  0.03 0.76 0.24
## 0011.HK    7  0.75 -0.07  0.16  0.17 -0.07 0.70 0.30
## 0013.HK    9  0.71  0.13 -0.03  0.03  0.09 0.75 0.25
## 0101.HK   16  0.70  0.16 -0.01 -0.10  0.05 0.63 0.37
## 2388.HK   45  0.63  0.23  0.08  0.13 -0.18 0.70 0.30
## 2318.HK   44  0.61  0.42 -0.05 -0.07 -0.06 0.74 0.26
## 1109.HK   37  0.57  0.43 -0.32 -0.01 -0.04 0.70 0.30
## 0688.HK   27  0.56  0.48 -0.21 -0.03 -0.13 0.71 0.29
## 0267.HK   19  0.55  0.16 -0.11  0.13  0.18 0.66 0.34
## 1398.HK   40  0.54  0.45  0.05  0.03 -0.08 0.81 0.19
## 0023.HK   13  0.53  0.11  0.18  0.28 -0.18 0.64 0.36
## 0005.HK    5  0.53  0.37  0.07 -0.06  0.06 0.74 0.26
## 2600.HK   46  0.51  0.45 -0.05 -0.08 -0.04 0.64 0.36
## 0019.HK   12  0.50 -0.10  0.04  0.20  0.16 0.43 0.57
## 3988.HK   49  0.48  0.37  0.07  0.05  0.03 0.73 0.27
## 0939.HK   33  0.47  0.41  0.09  0.06 -0.02 0.75 0.25
## 2628.HK   47  0.45  0.40  0.08 -0.09  0.04 0.64 0.36
## 0293.HK   21  0.45  0.18 -0.11  0.12  0.04 0.43 0.57
## 1299.HK   39  0.44  0.16  0.06  0.15 -0.01 0.47 0.53
## 0066.HK   14  0.40 -0.01  0.27  0.15  0.18 0.56 0.44
## 0291.HK   20  0.37  0.21 -0.03  0.06  0.11 0.39 0.61
## 0700.HK   28  0.21  0.70  0.01  0.02 -0.23 0.62 0.38
## 0386.HK   24 -0.07  0.68  0.30 -0.22  0.23 0.70 0.30
## 0762.HK   29 -0.16  0.61  0.26  0.18  0.08 0.59 0.41
## 0883.HK   32  0.32  0.58  0.09 -0.02  0.03 0.77 0.23
## 0144.HK   17  0.21  0.56 -0.07 -0.01  0.16 0.62 0.38
## 0857.HK   31  0.15  0.56  0.18 -0.10  0.24 0.74 0.26
## 1199.HK   38  0.41  0.54 -0.08 -0.14  0.08 0.69 0.31
## 1880.HK   41  0.08  0.54 -0.08  0.22 -0.02 0.50 0.50
## 3328.HK   48  0.43  0.49  0.05 -0.02  0.04 0.78 0.22
## 1088.HK   36  0.31  0.48  0.08  0.05  0.11 0.74 0.26
## 1898.HK   42  0.43  0.45  0.06 -0.02  0.04 0.71 0.29
## 0494.HK   26  0.27  0.43 -0.08  0.00  0.08 0.46 0.54
## 1928.HK   43  0.37  0.40 -0.09  0.25 -0.21 0.61 0.39
## 0002.HK    2  0.14 -0.01  0.86  0.06 -0.27 0.70 0.30
## 0006.HK    6 -0.18  0.29  0.83 -0.18 -0.28 0.61 0.39
## 0003.HK    3  0.32 -0.34  0.55  0.06  0.25 0.59 0.41
## 0941.HK   34 -0.10  0.34  0.48  0.06  0.22 0.59 0.41
## 0322.HK   22  0.00 -0.18  0.00  0.87 -0.01 0.63 0.37
## 0151.HK   18 -0.24  0.10 -0.11  0.68  0.38 0.57 0.43
## 1044.HK   35 -0.17  0.39  0.01  0.59  0.02 0.58 0.42
## 0836.HK   30 -0.03 -0.06 -0.21  0.17  0.78 0.53 0.47
## 0330.HK   23  0.07  0.20 -0.24 -0.12  0.59 0.41 0.59
```

```
##
##                  PC1  PC4  PC2  PC3  PC5
## SS loadings    15.12 9.44 2.72 2.32 1.96
## Proportion Var  0.31 0.19 0.06 0.05 0.04
## Cumulative Var  0.31 0.50 0.56 0.60 0.64
##
##  With component correlations of
##      PC1  PC4  PC2  PC3  PC5
## PC1 1.00 0.71 0.35 0.54 0.52
## PC4 0.71 1.00 0.30 0.51 0.45
## PC2 0.35 0.30 1.00 0.20 0.44
## PC3 0.54 0.51 0.20 1.00 0.27
## PC5 0.52 0.45 0.44 0.27 1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1176  and the objective function was  45.55 0.3
## The degrees of freedom for the model are 941  and the objective function was  7.59
##  0.3The number of observations was  247  with Chi Square =  1711  with prob <  2.3e-47
##  0.3
## Fit based upon off diagonal values = 1
##               PC1       PC4
## 0001.HK  0.841835  0.025327
## 0002.HK  0.137387 -0.009232
## 0003.HK  0.319151 -0.340712
## 0004.HK  0.797859  0.122246
## 0005.HK  0.531447  0.371024
## 0006.HK -0.176164  0.286420
## 0011.HK  0.748852 -0.065652
## 0012.HK  0.841877 -0.038393
## 0013.HK  0.712666  0.128422
## 0016.HK  0.928437 -0.042997
## 0017.HK  0.840495 -0.025749
## 0019.HK  0.495781 -0.102332
## 0023.HK  0.534329  0.112073
## 0066.HK  0.396413 -0.011350
## 0083.HK  0.809844  0.053931
## 0101.HK  0.697643  0.160535
## 0144.HK  0.213668  0.564180
## 0151.HK -0.236038  0.103635
## 0267.HK  0.546901  0.156212
## 0291.HK  0.365804  0.206859
## 0293.HK  0.449142  0.177332
## 0322.HK -0.002088 -0.183769
## 0330.HK  0.072964  0.196025
## 0386.HK -0.069663  0.679227
## 0388.HK  0.770024  0.146448
## 0494.HK  0.274550  0.431437
## 0688.HK  0.558659  0.480458
## 0700.HK  0.209643  0.701711
## 0762.HK -0.158543  0.608968
## 0836.HK -0.033323 -0.060871
## 0857.HK  0.148586  0.558181
## 0883.HK  0.317320  0.575481
## 0939.HK  0.467294  0.408337
## 0941.HK -0.100166  0.335427
## 1044.HK -0.174346  0.390625
```

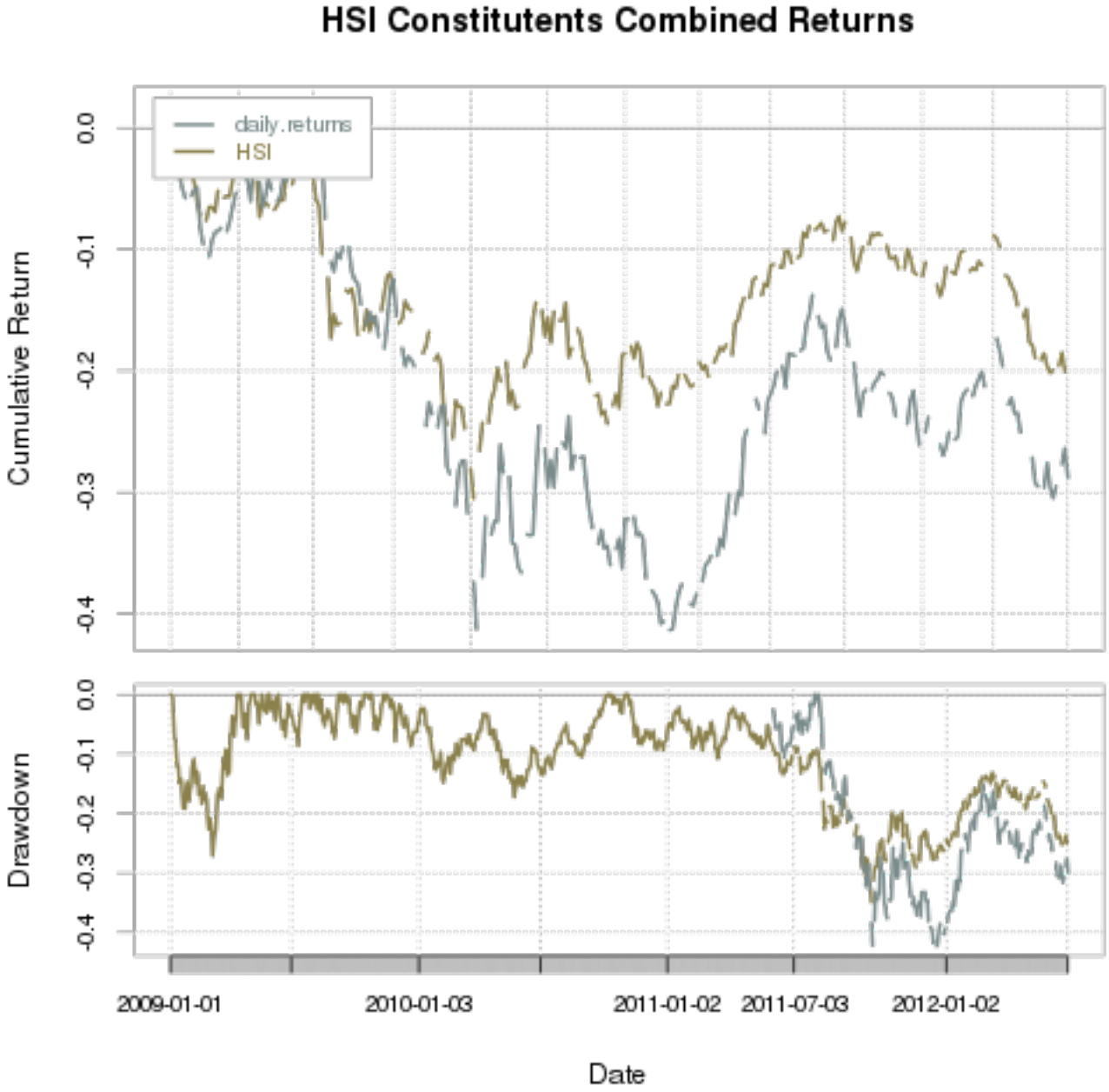
```
## 1088.HK  0.313465  0.481290
## 1109.HK  0.565599  0.427061
## 1199.HK  0.408119  0.543790
## 1299.HK  0.443514  0.158839
## 1398.HK  0.536965  0.446064
## 1880.HK  0.078377  0.540466
## 1898.HK  0.431172  0.446265
## 1928.HK  0.373701  0.401038
## 2318.HK  0.607222  0.416577
## 2388.HK  0.629088  0.233511
## 2600.HK  0.508505  0.448240
## 2628.HK  0.451537  0.404779
## 3328.HK  0.432342  0.491100
## 3988.HK  0.475240  0.370810
```



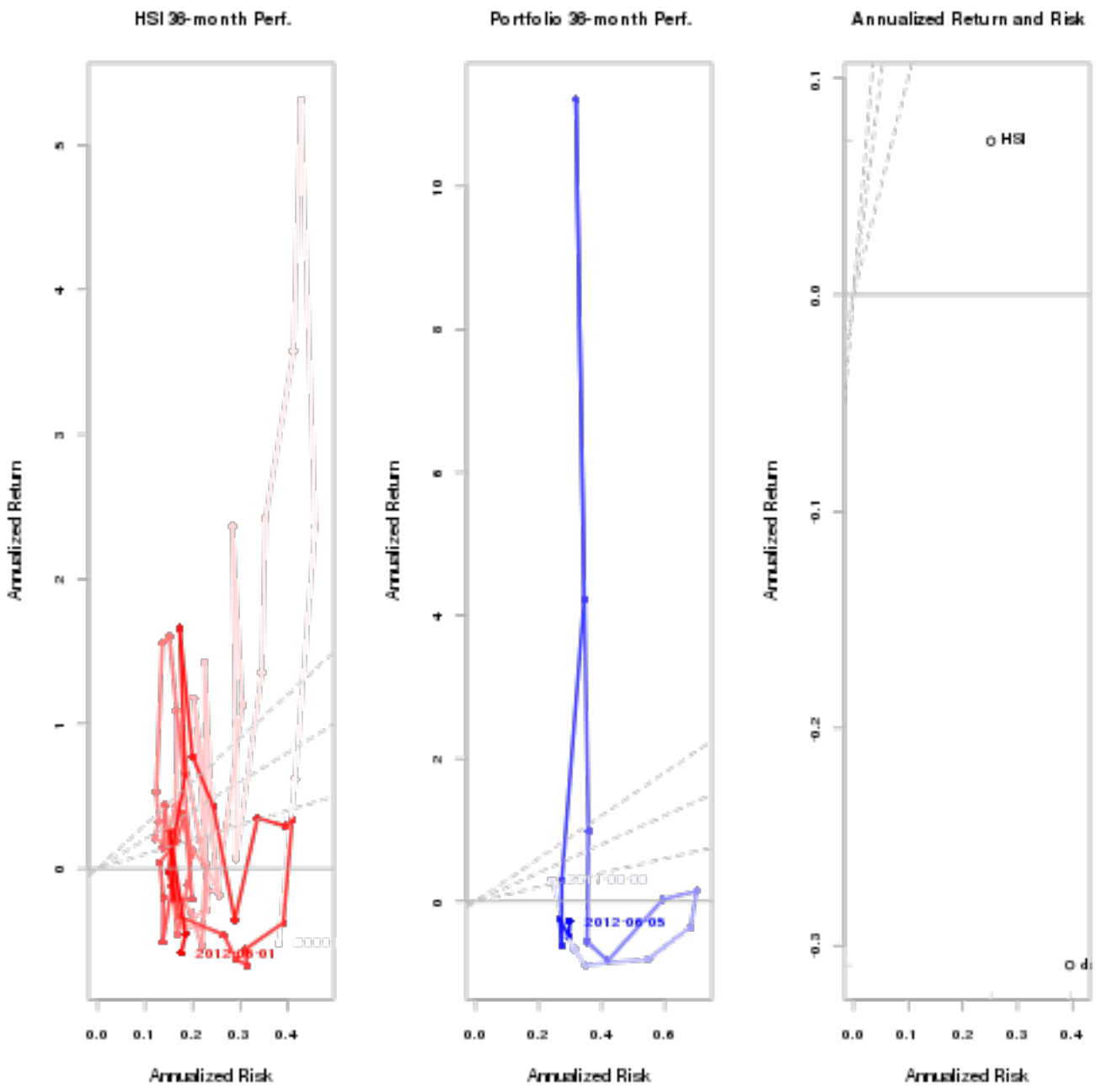
PCA is a science in itself and can not be fully covered and even less interpreted in this paper. The factors produced by principal component analysis are conceptualized as being linear combinations of the variables whereas the factors produced by common factor analysis are conceptualized as being latent variables. Note : Kaiser criterion: The Kaiser rule is to drop all components with eigenvalues under 1.0 – this being the eigenvalue equal to the information accounted for by an average single item.

6 HSI Components Performance

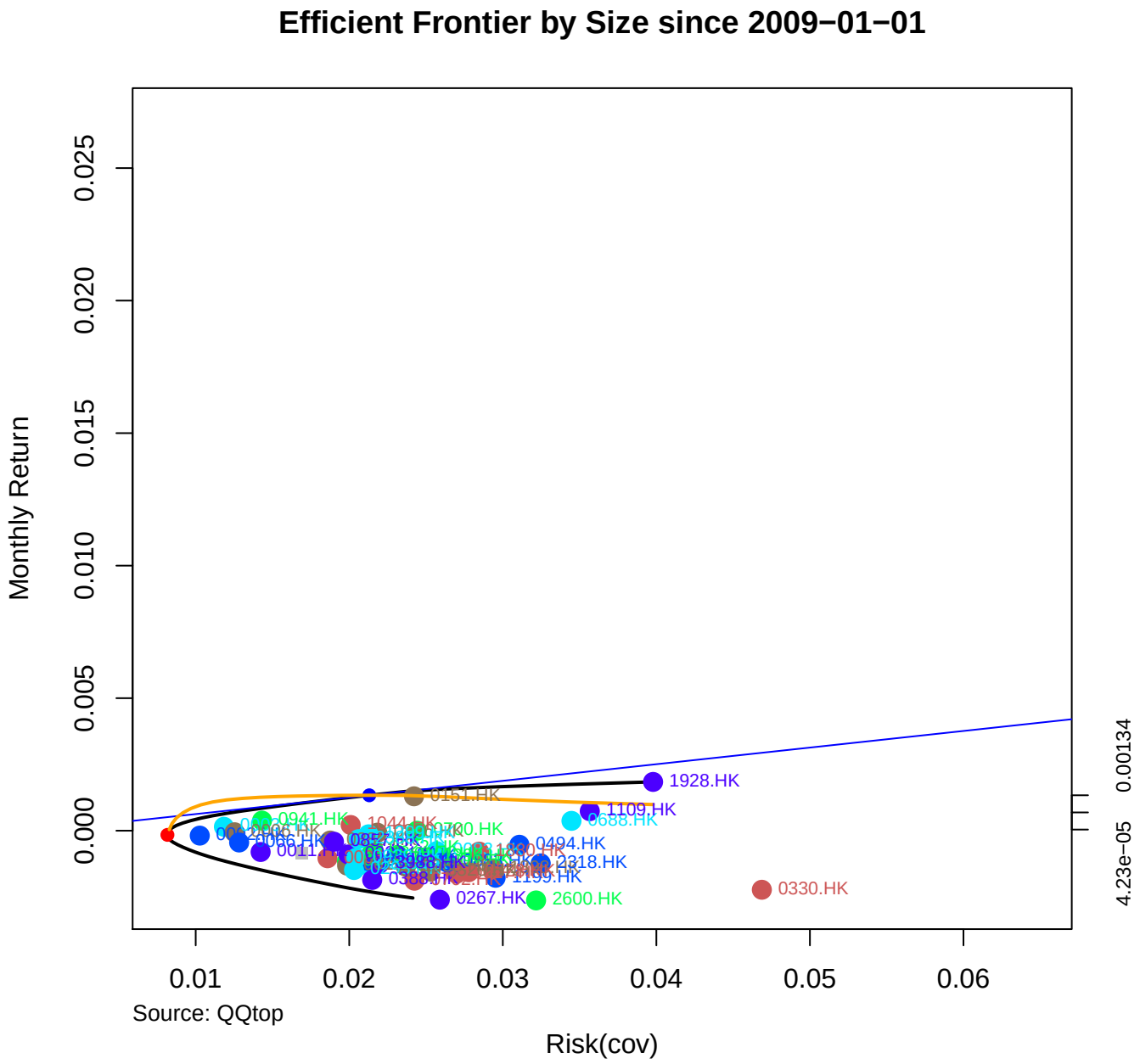
6.1 Performance Chart



6.2 Performance SnailTrail Chart



6.3 HSI Components Frontier




```
##
## Title:
##  MV Portfolio Frontier
##  Estimator:         covEstimator
##  Solver:            solveRquadprog
##  Optimize:          minRisk
##  Constraints:       LongOnly
##  Portfolio Points:  5 of 49
##
## Portfolio Weights:
##    0001.HK 0002.HK 0003.HK 0004.HK 0005.HK 0006.HK 0011.HK 0012.HK 0013.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0076  0.0000  0.0000  0.0000  0.2308  0.0000  0.0000  0.0000
```

```
## 25  0.0000  0.2514  0.1362  0.0000  0.0000  0.2256  0.0239  0.0000  0.0000
## 37  0.0000  0.0000  0.1898  0.0000  0.0000  0.1762  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    0016.HK 0017.HK 0019.HK 0023.HK 0066.HK 0083.HK 0101.HK 0144.HK 0151.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0662  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0418  0.0000  0.1154  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.3249
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK 0388.HK 0494.HK 0688.HK
## 1   0.6883  0.0000  0.0000  0.0000  0.0082  0.0000  0.0000  0.0000  0.0000
## 13  0.2169  0.0033  0.1634  0.0528  0.0168  0.0000  0.0945  0.0000  0.0000
## 25  0.0000  0.0212  0.0729  0.0724  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    0700.HK 0762.HK 0836.HK 0857.HK 0883.HK 0939.HK 0941.HK 1044.HK 1088.HK
## 1   0.0000  0.0917  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.1417  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0392  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.1801  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK 1928.HK 2318.HK 2388.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.1289  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  1.0000  0.0000  0.0000
##    2600.HK 2628.HK 3328.HK 3988.HK
## 1   0.2118  0.0000  0.0000  0.0000
## 13  0.0060  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000
##
## Covariance Risk Budgets:
##    0001.HK 0002.HK 0003.HK 0004.HK 0005.HK 0006.HK 0011.HK 0012.HK 0013.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0025  0.0000  0.0000  0.0000  0.0602  0.0000  0.0000  0.0000
## 25  0.0000  0.2420  0.1207  0.0000  0.0000  0.2106  0.0264  0.0000  0.0000
## 37  0.0000  0.0000  0.0868  0.0000  0.0000  0.0473  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    0016.HK 0017.HK 0019.HK 0023.HK 0066.HK 0083.HK 0101.HK 0144.HK 0151.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0617  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0511  0.0000  0.1180  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.4883
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK 0388.HK 0494.HK 0688.HK
## 1   0.7139  0.0000  0.0000  0.0000  0.0067  0.0000  0.0000  0.0000  0.0000
## 13  0.3508  0.0028  0.1668  0.0312  0.0238  0.0000  0.1153  0.0000  0.0000
## 25  0.0000  0.0251  0.0917  0.0778  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    0700.HK 0762.HK 0836.HK 0857.HK 0883.HK 0939.HK 0941.HK 1044.HK 1088.HK
## 1   0.0000  0.0562  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.1751  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0367  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.1202  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
##    1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK 1928.HK 2318.HK 2388.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.2574  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  1.0000  0.0000  0.0000
##    2600.HK 2628.HK 3328.HK 3988.HK
## 1   0.2232  0.0000  0.0000  0.0000
## 13  0.0099  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000  0.0000
##
## Target Return and Risks:
##       mean      mu     Cov   Sigma    CVaR     VaR
## 1  -0.0025 -0.0025  0.0241  0.0241  0.0572  0.0439
## 13 -0.0014 -0.0014  0.0140  0.0140  0.0311  0.0249
## 25 -0.0003 -0.0003  0.0083  0.0083  0.0188  0.0153
## 37  0.0007  0.0007  0.0131  0.0131  0.0302  0.0213
## 49  0.0018  0.0018  0.0398  0.0398  0.0817  0.0553
##
## Description:
##  Wed Jun  6 21:46:02 2012 by user:
```

7 HSI Components Ratios

7.1 Sharpe Ratio - Combined

```
##                                daily.returns
## StdDev Sharpe (Rf=0%, p=95%):       -0.0465
## VaR Sharpe (Rf=0%, p=95%):          -0.0296
## ES Sharpe (Rf=0%, p=95%):           -0.0229
```

7.2 Sharpe - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0168  0.0299  0.0420  0.0403       0
## VaR Sharpe (Rf=0%, p=95%):     0.0112  0.0189  0.0254  0.0276       0
## ES Sharpe (Rf=0%, p=95%):      0.0087  0.0134  0.0110  0.0217       0
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0311  0.0042  0.0239  0.0353  0.0245
## VaR Sharpe (Rf=0%, p=95%):     0.0200  0.0030  0.0166  0.0242  0.0158
## ES Sharpe (Rf=0%, p=95%):      0.0140  0.0030  0.0134  0.0188  0.0107
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0128  0.0328  0.0343  0.0351  0.0226
## VaR Sharpe (Rf=0%, p=95%):     0.0084  0.0205  0.0267  0.0258  0.0150
## ES Sharpe (Rf=0%, p=95%):      0.0059  0.0121  0.0267  0.0222  0.0110
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0266  0.0271  0.0679  0.0166  0.0349
## VaR Sharpe (Rf=0%, p=95%):     0.0183  0.0181  0.0459  0.0121  0.0231
## ES Sharpe (Rf=0%, p=95%):      0.0146  0.0141  0.0348  0.0105  0.0180
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0280  0.0511 -0.0278  0.0285  0.0273
## VaR Sharpe (Rf=0%, p=95%):     0.0183  0.0426 -0.0183  0.0183  0.0195
## ES Sharpe (Rf=0%, p=95%):      0.0137  0.0426 -0.0124  0.0138  0.0161
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## StdDev Sharpe (Rf=0%, p=95%): -0.0159  0.0268  0.0793  0.0135  0.0066
## VaR Sharpe (Rf=0%, p=95%):    -0.0099  0.0194  0.0528  0.0092  0.0043
## ES Sharpe (Rf=0%, p=95%):     -0.0079  0.0165  0.0390  0.0072  0.0034
##                                0857.HK 0883.HK 0939.HK 0941.HK 1044.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0271  0.0391  0.0202  0.0036  0.0670
## VaR Sharpe (Rf=0%, p=95%):     0.0171  0.0257  0.0126  0.0024  0.0463
## ES Sharpe (Rf=0%, p=95%):      0.0129  0.0193  0.0088  0.0018  0.0359
##                                1088.HK 1109.HK 1199.HK 1299.HK 1398.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0314  0.0290  0.0186  0.0209  0.0156
## VaR Sharpe (Rf=0%, p=95%):     0.0199  0.0213  0.0127  0.0132  0.0111
## ES Sharpe (Rf=0%, p=95%):      0.0152  0.0182  0.0101  0.0077  0.0092
##                                1880.HK 1898.HK 1928.HK 2318.HK 2388.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0667  0.0149  0.0668  0.0270  0.0583
## VaR Sharpe (Rf=0%, p=95%):     0.0477  0.0091  0.0546  0.0180  0.0420
## ES Sharpe (Rf=0%, p=95%):      0.0379  0.0062  0.0546  0.0129  0.0340
##                                2600.HK 2628.HK 3328.HK 3988.HK
## StdDev Sharpe (Rf=0%, p=95%):   1e-03 -0.0086  0.0024  0.0284
## VaR Sharpe (Rf=0%, p=95%):      6e-04 -0.0053  0.0015  0.0188
## ES Sharpe (Rf=0%, p=95%):       5e-04 -0.0037  0.0011  0.0137
```

7.3 Information Ratio - Combined

```
## [1] "Information Ratio :  -0.1493"
```

7.4 Information Ratio - Distinct

```
##                        0001.HK 0002.HK 0003.HK 0004.HK 0005.HK 0006.HK
## Information Ratio: HSI -0.1027 -0.0708  0.1813  0.2531 -0.3138 -0.0054
##                        0011.HK 0012.HK 0013.HK 0016.HK 0017.HK 0019.HK
## Information Ratio: HSI -0.2705 -0.0034  0.1591  0.0021 -0.1579  0.1168
```

```
##                         0023.HK 0066.HK 0083.HK 0101.HK 0144.HK 0151.HK
## Information Ratio: HSI   0.145  0.0892  -0.021  0.0368  0.0412  0.6946
##                         0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK
## Information Ratio: HSI -0.1082  0.1589  0.0555  0.4057 -0.6707  0.0574
##                         0388.HK 0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Information Ratio: HSI   0.044  0.0064  0.0394  0.9635 -0.1392  -0.231
##                         0857.HK 0883.HK 0939.HK 0941.HK 1044.HK 1088.HK
## Information Ratio: HSI  0.0366  0.2259  -0.057 -0.2607  0.7005   0.109
##                         1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK
## Information Ratio: HSI  0.0695  -0.088  0.5448 -0.1161  0.7573 -0.1387
##                         1928.HK 2318.HK 2388.HK 2600.HK 2628.HK 3328.HK
## Information Ratio: HSI   1.017  0.0417  0.5323 -0.3289 -0.4119 -0.2939
##                         3988.HK
## Information Ratio: HSI  0.0595
```

8 HSI Components Table Latest Quotes

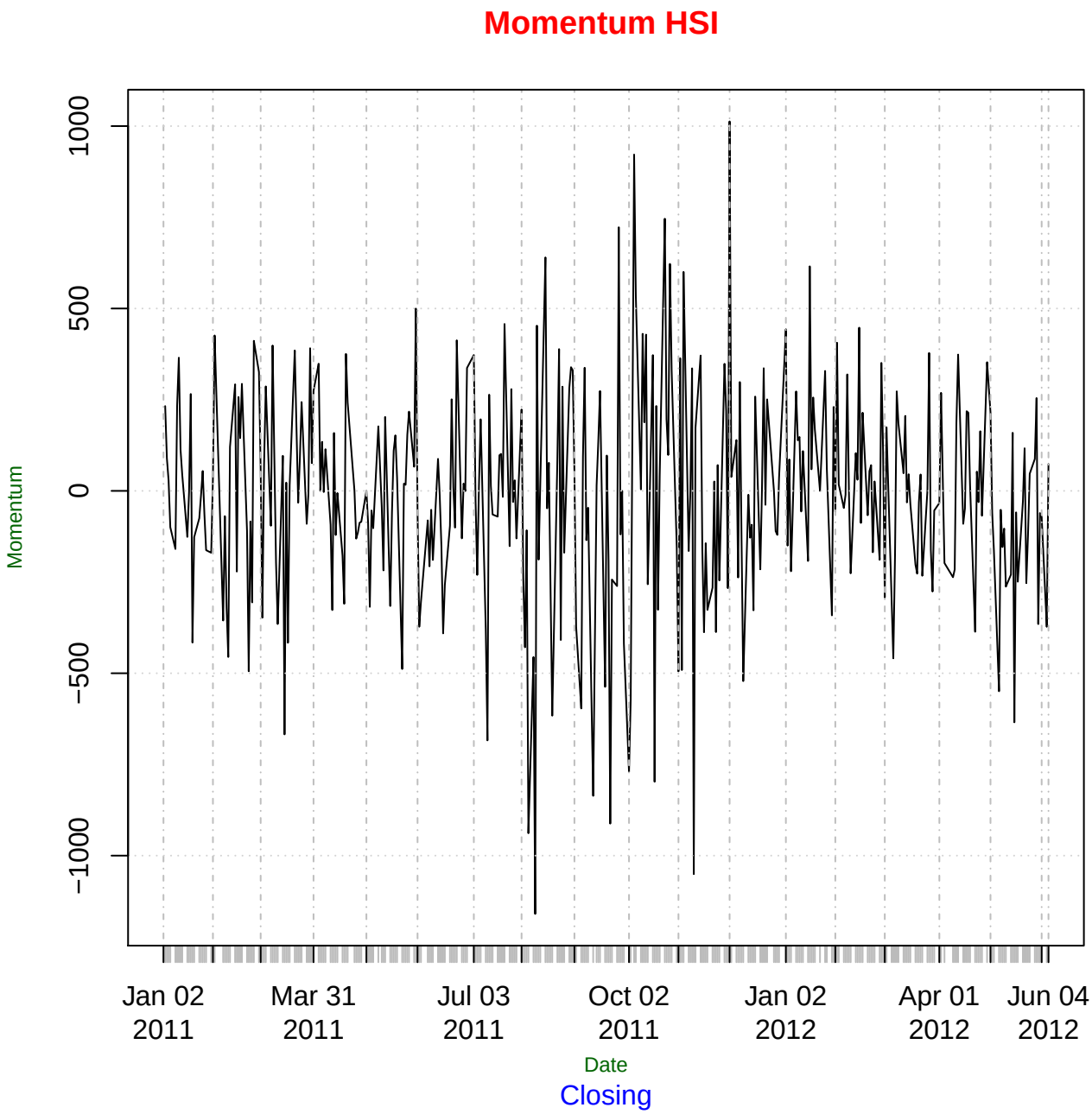
```
## [1] "Date :  2012-06-06 03:59:00"
##                    Name    Bid    Ask Change   52-week Range
## 0001.HK     CHEUNG KONG  88.05  88.20  1.550  79.10 - 122.40
## 0002.HK    CLP HOLDINGS  63.35  63.70  0.450   62.10 - 75.20
## 0003.HK  HK & CHINA GAS  18.50  18.54  0.080   16.68 - 20.65
## 0004.HK  WHARF HOLDINGS  41.00  41.05  1.250   33.15 - 59.00
## 0005.HK   HSBC HOLDINGS  61.90  62.00  1.550   56.00 - 80.25
## 0006.HK    POWER ASSETS  54.35  54.45  0.000   52.55 - 64.80
## 0011.HK  HANG SENG BANK 100.10 100.50  0.300  84.40 - 125.00
## 0012.HK  HENDERSON LAND  40.40  40.60  1.900   33.20 - 51.05
## 0013.HK       HUTCHISON  62.30  62.50  0.500   53.60 - 93.10
## 0016.HK         SHK PPT  87.65  88.05  2.050  85.30 - 122.00
## 0017.HK   NEW WORLD DEV   8.63   8.67  0.500    6.13 - 12.84
## 0019.HK SWIRE PACIFIC A  83.50  83.60  1.500  75.10 - 117.90
## 0023.HK  BANK OF E ASIA  25.65  25.75 -0.050   21.85 - 33.15
## 0066.HK MTR CORPORATION  25.05  25.10 -0.150   22.45 - 28.00
## 0083.HK       SINO LAND  10.74  10.76  0.420    9.28 - 14.16
## 0101.HK   HANG LUNG PPT  25.05  25.35  0.450   20.85 - 32.95
## 0144.HK  CHINA MER HOLD  21.40  21.45  0.300   19.00 - 31.30
## 0151.HK WANT WANT CHINA   9.44   9.50  0.100    6.03 - 10.24
## 0267.HK   CITIC PACIFIC  10.98  11.10  0.080   10.26 - 22.20
## 0291.HK CHINA RESOURCES  22.50  22.55  0.300   24.00 - 35.50
## 0293.HK  CATHAY PAC AIR  12.16  12.18 -0.040   11.76 - 18.88
## 0322.HK          TINGYI  18.94  19.00  0.340   17.84 - 26.00
## 0330.HK ESPRIT HOLDINGS  12.50  12.52  0.340    7.55 - 28.65
## 0386.HK    SINOPEC CORP   6.99   7.00  0.190     6.22 - 9.67
## 0388.HK            HKEX 106.00 106.10  2.100  99.15 - 171.20
## 0494.HK       LI & FUNG  14.44  14.46  0.320   10.82 - 20.15
## 0688.HK  CHINA OVERSEAS  15.64  15.66  0.360    9.99 - 17.86
## 0700.HK         TENCENT 217.00 217.20  7.800 139.80 - 248.80
## 0762.HK    CHINA UNICOM  10.24  10.28  0.200   10.28 - 17.64
## 0836.HK CHINA RES POWER  14.24  14.26  0.220   10.82 - 16.20
## 0857.HK      PETROCHINA   9.89   9.91  0.240    8.59 - 11.92
## 0883.HK           CNOOC  13.76  13.80  0.500   11.20 - 18.96
## 0939.HK             CCB   5.45   5.46  0.090     4.41 - 7.09
## 0941.HK    CHINA MOBILE  78.90  78.95  2.250   68.20 - 89.85
## 1044.HK    HENGAN INT'L  72.70  72.80  1.800   56.80 - 83.45
## 1088.HK   CHINA SHENHUA  25.10  25.15 -0.700   26.85 - 40.20
## 1109.HK  CHINA RES LAND  14.58  14.66  0.440    7.28 - 15.60
## 1199.HK   COSCO PACIFIC   9.00   9.04  0.170    7.52 - 14.76
## 1299.HK             AIA  25.30  25.35  0.100   19.84 - 29.90
## 1398.HK            ICBC   4.45   4.47  0.028     3.46 - 6.08
## 1880.HK     BELLE INT'L  12.28  12.36  0.100   11.38 - 17.54
## 1898.HK      CHINA COAL   6.59   6.60 -0.010    6.59 - 11.66
## 1928.HK SANDS CHINA LTD  26.20  26.35  0.930   14.90 - 33.05
## 2318.HK         PING AN  55.65  55.85  1.900   37.35 - 83.75
## 2388.HK   BOC HONG KONG  21.45  21.60  0.300   14.24 - 24.45
## 2600.HK          CHALCO   3.15   3.16  0.060     3.08 - 6.88
## 2628.HK      CHINA LIFE  17.42  17.46  0.380   17.04 - 28.10
## 3328.HK        BANKCOMM   5.10   5.11  0.100     4.15 - 7.80
## 3988.HK   BANK OF CHINA   2.81   2.82  0.039     2.20 - 4.05
```

9 Hang Seng Index

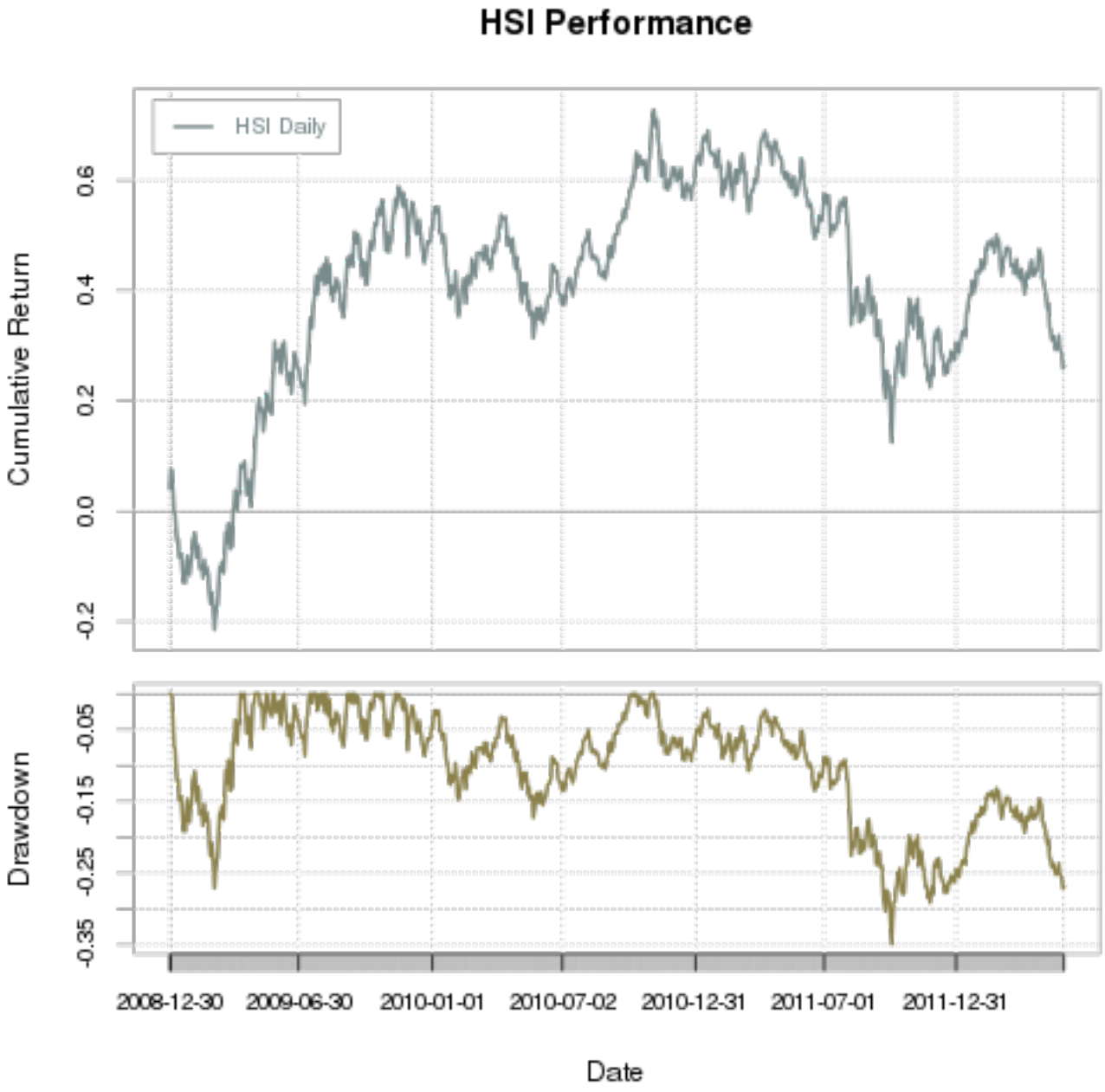
Latest Hang Seng Index

	Trade Time	Name	Last	Change	Days Range	52−week Range
^HSI	2012−06−06 04:01:00	HANG SENG INDEX	18521	261.5	18320.609 − 18521.57	16170.30 − 22835.00

9.1 Hang Seng Index - Momentum

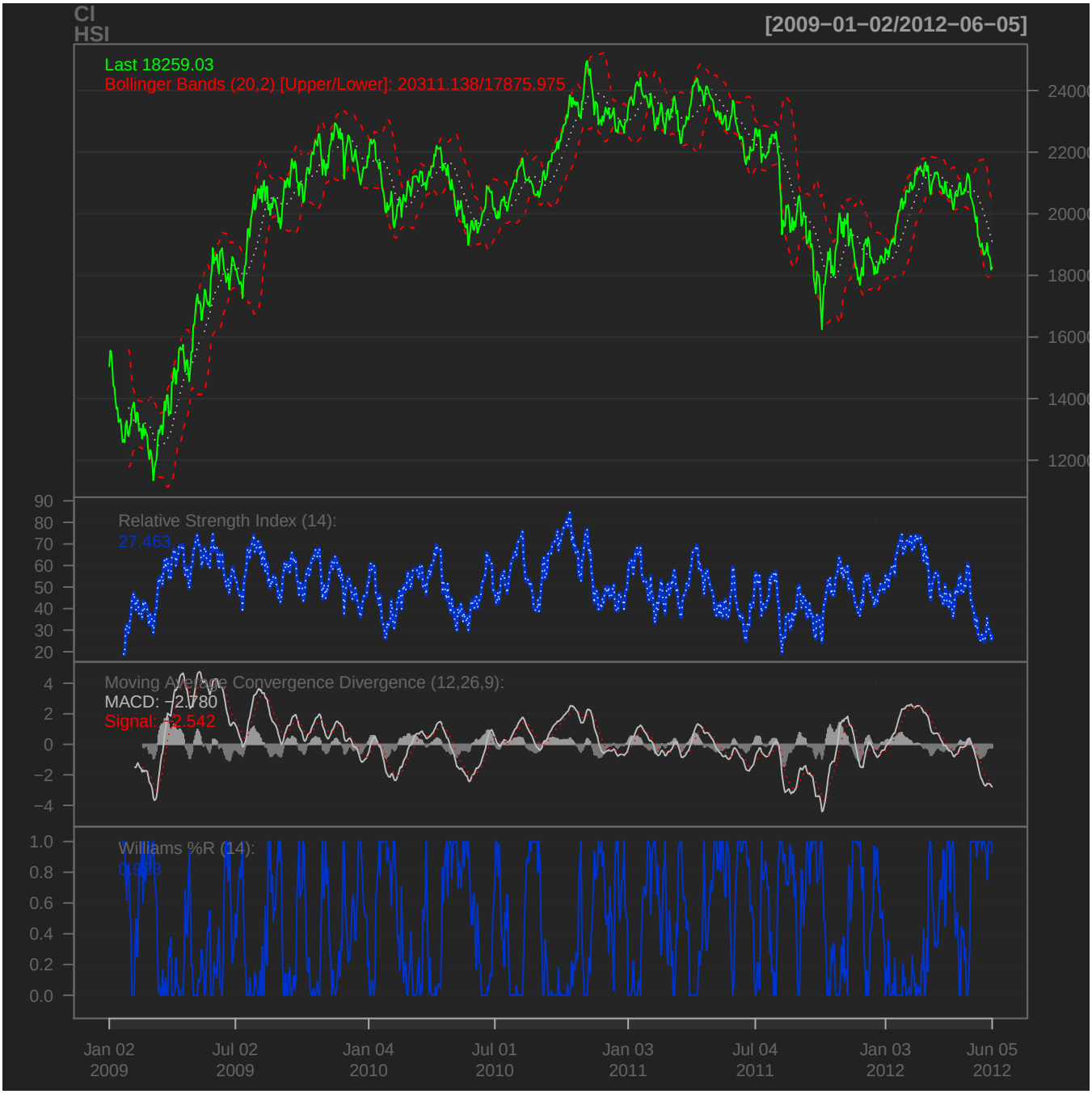


9.2 HSI Performance

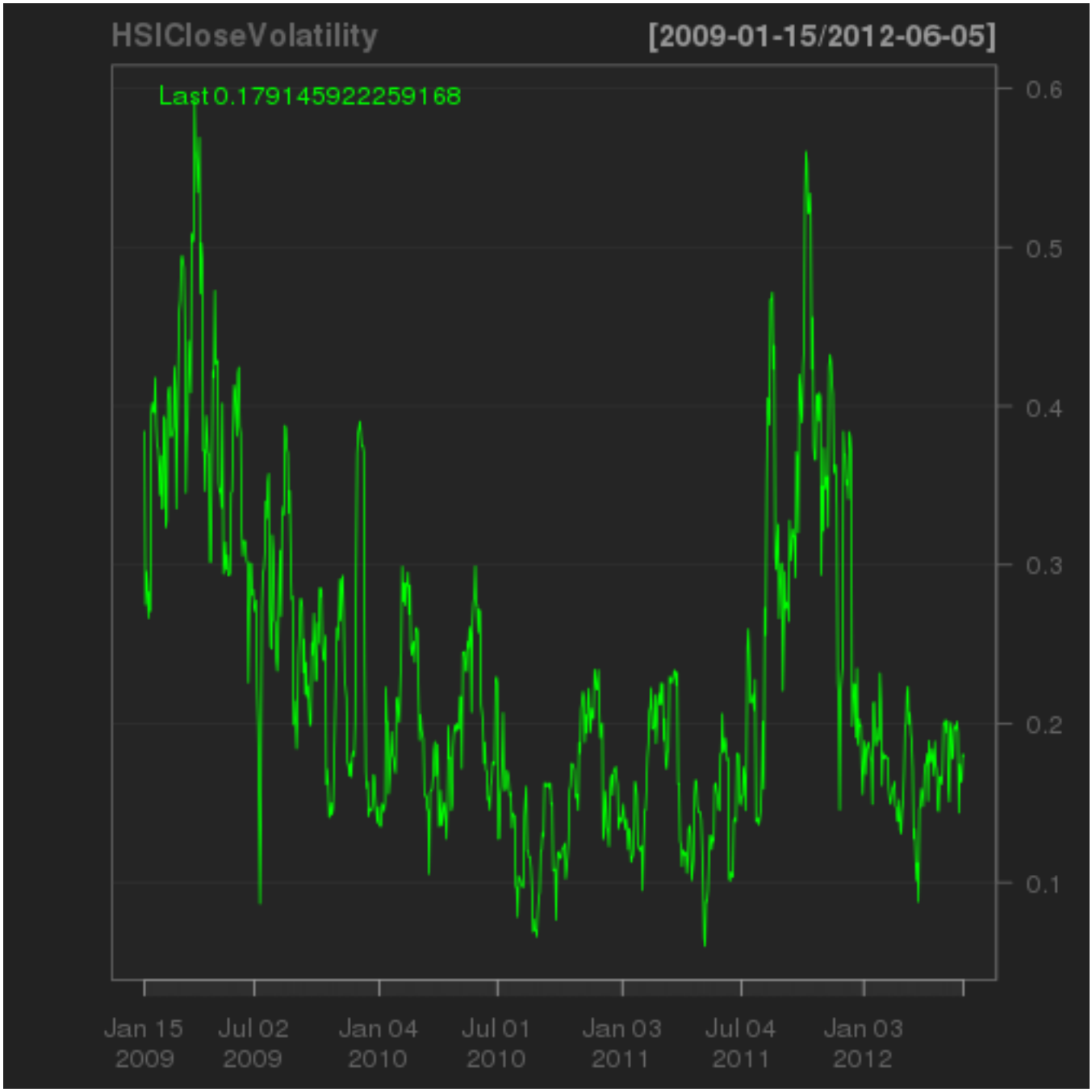


9.3 HSI Ratios

```
##                RSI
## 2012-05-22 25.76
## 2012-05-23 24.58
## 2012-05-24 26.01
## 2012-05-27 28.70
## 2012-05-28 36.01
## 2012-05-29 31.09
## 2012-05-30 30.34
## 2012-05-31 29.46
## 2012-06-03 25.28
## 2012-06-04 27.46
##                macd signal
## 2012-05-22 -2.481 -1.684
## 2012-05-23 -2.637 -1.875
## 2012-05-24 -2.714 -2.042
## 2012-05-27 -2.708 -2.175
## 2012-05-28 -2.569 -2.254
## 2012-05-29 -2.583 -2.320
## 2012-05-30 -2.591 -2.374
## 2012-05-31 -2.599 -2.419
## 2012-06-03 -2.734 -2.482
## 2012-06-04 -2.780 -2.542
## [1] "BBands"
##                 dn  mavg    up   pctB
## 2012-05-22 18463 20113 21764 0.0980
## 2012-05-23 18269 20014 21760 0.1139
## 2012-05-24 18116 19910 21703 0.1665
## 2012-05-27 18000 19813 21625 0.2210
## 2012-05-28 17970 19711 21452 0.3118
## 2012-05-29 17949 19580 21211 0.2273
## 2012-05-30 17961 19449 20937 0.2247
## 2012-05-31 17991 19322 20654 0.2130
## 2012-06-03 17908 19205 20501 0.1069
## 2012-06-04 17876 19094 20311 0.1573
##               WPR %
## 2012-05-22 100.00
## 2012-05-23 100.00
## 2012-05-24  97.41
## 2012-05-27  91.91
## 2012-05-28  75.07
## 2012-05-29  98.17
## 2012-05-30 100.00
## 2012-05-31 100.00
## 2012-06-03 100.00
## 2012-06-04  92.77
```


CI
HSI
[2009−01−02/2012−06−05]
Last 18259.03
Bollinger Bands (20,2) [Upper/Lower]: 20311.138/17875.975
24000
22000
20000
18000
16000
14000
12000
90
80
70
60
50
40
30
20
Relative Strength Index (14):
27.463
4
2
0
−2
−4
Moving Average Convergence Divergence (12,26,9):
MACD: −2.780
Signal: −2.542
1.0
0.8
0.6
0.4
0.2
0.0
Williams %R (14):
Jan 02
2009
Jul 02
2009
Jan 04
2010
Jul 01
2010
Jan 03
2011
Jul 04
2011
Jan 03
2012
Jun 05
2012

9.4 HSI Volatility



9.5 HSI Statistics

```
##                                HSI-Daily HSI-Monthly
## StdDev Sharpe (Rf=0%, p=95%):   0.02506     0.09995
## VaR Sharpe (Rf=0%, p=95%):      0.01616     0.06694
## ES Sharpe (Rf=0%, p=95%):       0.01192     0.05341
##          HSI-Daily HSI-Monthly
## Skewness    0.1292      0.1095
##          HSI-Daily HSI-Monthly
## Kurtosis      1.51     -0.1453
```

```
##      Index              HSI Daily
##  Min.   :2008-12-31   Min.   :-5.66e-02
##  1st Qu.:2009-11-07   1st Qu.:-8.12e-03
##  Median :2010-09-13   Median : 3.22e-05
##  Mean   :2010-09-15   Mean   : 3.96e-04
##  3rd Qu.:2011-07-23   3rd Qu.: 9.91e-03
##  Max.   :2012-06-03   Max.   : 7.41e-02
##      Index             HSI Monthly
##  Min.   :2009-01-28   Min.   :-0.14329
##  1st Qu.:2009-12-05   1st Qu.:-0.03222
##  Median :2010-10-12   Median : 0.00564
##  Mean   :2010-10-12   Mean   : 0.00701
##  3rd Qu.:2011-08-20   3rd Qu.: 0.03680
##  Max.   :2012-06-03   Max.   : 0.17074
```

10 Dataset First and Last Rows Info

```
##            X0001.HK.Close
## 2009-01-02          76.90
## 2012-06-05          86.35
##            X0002.HK.Close
## 2009-01-02          52.40
## 2012-06-05          63.05
##            X0003.HK.Close
## 2009-01-02          12.08
## 2012-06-05          18.42
##            X0004.HK.Close
## 2009-01-02           22.0
## 2012-06-05           39.8
##            X0005.HK.Close
## 2009-01-02          77.00
## 2012-06-05          60.35
##            X0006.HK.Close
## 2009-01-02          42.75
## 2012-06-05          54.30
##            X0011.HK.Close
## 2009-01-02          104.7
## 2012-06-05          100.2
##            X0012.HK.Close
## 2009-01-02          30.35
## 2012-06-05          38.65
##            X0013.HK.Close
## 2009-01-02          39.85
## 2012-06-05          61.85
##            X0016.HK.Close
## 2009-01-02          67.30
## 2012-06-05          86.15
##            X0017.HK.Close
## 2009-01-02           8.18
## 2012-06-05           8.15
##            X0019.HK.Close
## 2009-01-02          55.75
## 2012-06-05          82.05
##            X0023.HK.Close
## 2009-01-02          16.68
## 2012-06-05          25.80
##            X0066.HK.Close
## 2009-01-02          18.08
## 2012-06-05          25.20
##            X0083.HK.Close
## 2009-01-02           8.36
## 2012-06-05          10.34
##            X0101.HK.Close
## 2009-01-02          18.36
## 2012-06-05          24.80
##            X0144.HK.Close
## 2009-01-02          15.40
## 2012-06-05          21.05
##            X0151.HK.Close
## 2009-01-02           3.17
## 2012-06-05           9.40
##            X0267.HK.Close
```

```
## 2009-01-02          10.20
## 2012-06-05          10.98
##            X0291.HK.Close
## 2009-01-02           14.0
## 2012-06-05           22.2
##            X0293.HK.Close
## 2009-01-02           8.91
## 2012-06-05          12.24
##            X0322.HK.Close
## 2009-01-02           8.98
## 2012-06-05          18.58
##            X0330.HK.Close
## 2009-01-02          44.80
## 2012-06-05          12.22
##            X0386.HK.Close
## 2009-01-02           4.96
## 2012-06-05           6.81
##            X0388.HK.Close
## 2009-01-02           76.6
## 2012-06-05          103.9
##            X0494.HK.Close
## 2011-06-02          17.92
## 2012-06-05          14.08
##            X0688.HK.Close
## 2009-01-02          11.22
## 2012-06-05          15.26
##            X0700.HK.Close
## 2009-01-01           50.0
## 2012-06-05          208.4
##            X0762.HK.Close
## 2009-01-01           9.63
## 2012-06-05          10.06
##            X0836.HK.Close
## 2009-01-02          15.12
## 2012-06-05          14.08
##            X0857.HK.Close
## 2009-01-02           7.20
## 2012-06-05           9.65
##            X0883.HK.Close
## 2009-01-02           7.59
## 2012-06-05          13.28
##            X0939.HK.Close
## 2009-01-02           4.52
## 2012-06-05           5.37
##            X0941.HK.Close
## 2009-01-02           81.2
## 2012-06-05           76.6
##            X1044.HK.Close
## 2009-01-01           24.9
## 2012-06-05           71.0
##            X1088.HK.Close
## 2009-01-02          17.40
## 2012-06-05          25.85
##            X1109.HK.Close
## 2009-01-02           9.90
## 2012-06-05          14.18
##            X1199.HK.Close
```

```
## 2009-01-02           8.07
## 2012-06-05           8.82
##            X1299.HK.Close
## 2010-10-29          23.10
## 2012-06-05          25.15
##            X1398.HK.Close
## 2009-01-02            4.3
## 2012-06-05            4.7
##            X1880.HK.Close
## 2009-01-02           3.50
## 2012-06-05          12.26
##            X1898.HK.Close
## 2009-01-02           6.55
## 2012-06-05           6.59
##            X1928.HK.Close
## 2009-11-30           9.31
## 2012-06-05          26.00
##            X2318.HK.Close
## 2009-01-02           39.6
## 2012-06-05           53.9
##            X2388.HK.Close
## 2009-01-02           9.06
## 2012-06-05          21.20
##            X2600.HK.Close
## 2009-01-02           4.55
## 2012-06-05           3.09
##            X2628.HK.Close
## 2009-01-02          24.75
## 2012-06-05          17.08
##            X3328.HK.Close
## 2009-01-02           5.91
## 2012-06-05           5.00
##            X3988.HK.Close
## 2009-01-02           2.17
## 2012-06-05           2.98
```

11 Notes

This paper was generated using R and following R libraries :
qmao XML quantmod PerformanceAnalytics
fPortfolio fBasic grid gridExtra knitr

Market Data Source : yahoo.finance

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