CAPM and other Statistics for HSI Components Version 1.1

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Contents

*No funding received yet. Please donate urgently
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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                               -0.0003
## Beta                                 0.0087
## Beta+                               -0.3850
## Beta-                                0.2673
## R-squared                            0.0000
## Annualized Alpha                    -0.0614
## Correlation                          0.0056
## Correlation p-value                  0.9392
## Tracking Error                       0.4625
## Active Premium                      -0.0309
## Information Ratio                   -0.0669
## Treynor Ratio                      -14.9009
```

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

CAPM - Distinct for each stock

```
## Error: 'names' attribute [49] must be the same length as the vector [48]
##                      X0001.HK to HSI X0002.HK to HSI X0003.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           1.048           0.235           0.314
## Beta+                          1.044           0.037          -0.076
## Beta-                          1.021           0.264           0.510
## R-squared                      0.744           0.143           0.188
## Annualized Alpha              -0.020           0.004           0.089
## Correlation                    0.863           0.378           0.434
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.161           0.251           0.248
## Active Premium                -0.036           0.164           0.222
## Information Ratio             -0.224           0.656           0.896
## Treynor Ratio                 -0.247          -0.249          -0.003
##                      X0004.HK to HSI X0005.HK to HSI X0006.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           1.205           1.011           0.143
## Beta+                          1.210           0.914          -0.061
## Beta-                          1.161           1.107           0.210
## R-squared                      0.632           0.797           0.035
## Annualized Alpha              -0.021          -0.030           0.006
## Correlation                    0.795           0.893           0.187
## Correlation p-value            0.000           0.000           0.003
## Tracking Error                 0.247           0.134           0.298
## Active Premium                -0.081          -0.033           0.179
## Information Ratio             -0.329          -0.246           0.600
## Treynor Ratio                 -0.253          -0.253          -0.309
##                      X0011.HK to HSI X0012.HK to HSI X0013.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           0.657           1.001           1.039
## Beta+                          0.667           0.953           0.948
## Beta-                          0.742           0.969           1.114
## R-squared                      0.573           0.595           0.684
## Annualized Alpha              -0.058           0.001          -0.050
## Correlation                    0.757           0.771           0.827
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.174           0.216           0.185
## Active Premium                 0.019          -0.017          -0.059
## Information Ratio              0.109          -0.079          -0.320
## Treynor Ratio                 -0.311          -0.240          -0.272
##                      X0016.HK to HSI X0017.HK to HSI X0019.HK to HSI
## Alpha                          0.000           0.000          -0.001
## Beta                           0.912           1.111           0.704
## Beta+                          0.983           0.681           0.697
## Beta-                          0.716           1.284           0.647
## R-squared                      0.570           0.462           0.338
## Annualized Alpha              -0.076          -0.128          -0.145
## Correlation                    0.755           0.680           0.582
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.209           0.315           0.269
## Active Premium                -0.057          -0.154          -0.080
## Information Ratio             -0.274          -0.487          -0.299
## Treynor Ratio                 -0.308          -0.339          -0.432
##                      X0023.HK to HSI X0066.HK to HSI X0083.HK to HSI
## Alpha                          0.000           0.000           0.000
```

```
## Beta                          0.890           0.521           1.178
## Beta+                         1.058           0.476           1.281
## Beta-                         0.817           0.554           1.247
## R-squared                     0.537           0.445           0.571
## Annualized Alpha             -0.022           0.004           0.095
## Correlation                   0.732           0.667           0.756
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.219           0.197           0.271
## Active Premium               -0.011           0.101           0.002
## Information Ratio            -0.051           0.512           0.007
## Treynor Ratio                -0.263          -0.234          -0.188
##                     X0101.HK to HSI X0144.HK to HSI X0151.HK to HSI
## Alpha                         0.000           0.000           0.002
## Beta                          1.074           1.173           0.664
## Beta+                         1.116           1.275           0.536
## Beta-                         1.141           1.213           0.822
## R-squared                     0.578           0.542           0.204
## Annualized Alpha              0.000          -0.005           0.490
## Correlation                   0.761           0.736           0.451
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.241           0.286           0.355
## Active Premium               -0.038          -0.071           0.421
## Information Ratio            -0.156          -0.248           1.185
## Treynor Ratio                -0.243          -0.251           0.298
##                     X0267.HK to HSI X0291.HK to HSI X0293.HK to HSI
## Alpha                        -0.001           0.000          -0.001
## Beta                          1.172           0.753           0.741
## Beta+                         1.459           0.690           0.953
## Beta-                         1.014           0.910           0.614
## R-squared                     0.565           0.373           0.366
## Annualized Alpha             -0.288           0.010          -0.211
## Correlation                   0.752           0.610           0.605
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.273           0.264           0.264
## Active Premium               -0.270           0.037          -0.139
## Information Ratio            -0.988           0.139          -0.526
## Treynor Ratio                -0.421          -0.248          -0.489
##                     X0322.HK to HSI X0330.HK to HSI X0386.HK to HSI
## Alpha                         0.000          -0.001           0.000
## Beta                          0.448           1.127           0.790
## Beta+                         0.720           1.095           0.722
## Beta-                         0.493           1.276           0.589
## R-squared                     0.114           0.156           0.479
## Annualized Alpha             -0.111          -0.262           0.120
## Correlation                   0.337           0.394           0.692
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.358           0.688           0.222
## Active Premium               -0.018          -0.342           0.125
## Information Ratio            -0.050          -0.496           0.563
## Treynor Ratio                -0.538          -0.501          -0.124
##                     X0388.HK to HSI X0494.HK to HSI X0688.HK to HSI
## Alpha                        -0.001           0.001           0.002
## Beta                          1.083           1.224           1.571
## Beta+                         1.148           1.130           2.273
## Beta-                         1.034           1.067           1.364
## R-squared                     0.690           0.423           0.566
## Annualized Alpha             -0.155           0.238           0.724
```

```
## Correlation                   0.831           0.651           0.752
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.191           0.379           0.390
## Active Premium               -0.147           0.063           0.280
## Information Ratio            -0.770           0.168           0.717
## Treynor Ratio                -0.342          -0.131           0.036
##                      X0700.HK to HSI X0762.HK to HSI X0836.HK to HSI
## Alpha                          0.001          -0.001           0.000
## Beta                           1.044           0.961           0.473
## Beta+                          1.329           1.073           0.235
## Beta-                          0.960           1.016           0.589
## R-squared                      0.495           0.440           0.127
## Annualized Alpha               0.298          -0.184           0.058
## Correlation                    0.704           0.663           0.357
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.276           0.284           0.353
## Active Premium                 0.183          -0.161           0.122
## Information Ratio              0.662          -0.567           0.345
## Treynor Ratio                 -0.039          -0.400          -0.215
##                      X0857.HK to HSI X0883.HK to HSI X0939.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           0.938           1.394           1.097
## Beta+                          0.857           1.663           1.142
## Beta-                          0.928           1.419           1.033
## R-squared                      0.657           0.761           0.781
## Annualized Alpha               0.131           0.084          -0.044
## Correlation                    0.811           0.872           0.884
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.178           0.229           0.154
## Active Premium                 0.103          -0.044          -0.063
## Information Ratio              0.580          -0.193          -0.411
## Treynor Ratio                 -0.128          -0.192          -0.261
##                      X0941.HK to HSI X1044.HK to HSI X1088.HK to HSI
## Alpha                          0.001           0.001           0.000
## Beta                           0.532           0.648           1.204
## Beta+                          0.307           0.813           1.189
## Beta-                          0.509           0.703           1.236
## R-squared                      0.375           0.284           0.719
## Annualized Alpha               0.274           0.276           0.017
## Correlation                    0.612           0.533           0.848
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.218           0.285           0.204
## Active Premium                 0.329           0.277          -0.047
## Information Ratio              1.511           0.972          -0.230
## Treynor Ratio                  0.199           0.083          -0.224
##                      X1109.HK to HSI X1199.HK to HSI X1299.HK to HSI
## Alpha                          0.002           0.000           0.001
## Beta                           1.548           1.409           0.865
## Beta+                          2.151           1.355           0.798
## Beta-                          1.228           1.555           1.120
## R-squared                      0.509           0.623           0.446
## Annualized Alpha               0.796          -0.072           0.173
## Correlation                    0.714           0.789           0.668
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.423           0.306           0.255
## Active Premium                 0.316          -0.166           0.140
## Information Ratio              0.747          -0.541           0.549
```

```
## Treynor Ratio                0.060          -0.276          -0.096
##                     X1398.HK to HSI X1880.HK to HSI X1898.HK to HSI
## Alpha                         0.000           0.000           0.000
## Beta                          1.378           1.087           1.468
## Beta+                         1.631           1.301           1.538
## Beta-                         1.216           0.934           1.373
## R-squared                     0.818           0.396           0.685
## Annualized Alpha              0.037           0.042           0.047
## Correlation                   0.905           0.630           0.828
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.197           0.352           0.288
## Active Premium               -0.068          -0.034          -0.095
## Information Ratio            -0.344          -0.098          -0.331
## Treynor Ratio                -0.211          -0.237          -0.217
##                     X2318.HK to HSI X2388.HK to HSI X2600.HK to HSI
## Alpha                         0.000           0.001          -0.001
## Beta                          1.641           0.990           1.484
## Beta+                         1.961           1.011           1.626
## Beta-                         1.329           1.076           1.275
## R-squared                     0.692           0.641           0.578
## Annualized Alpha              0.120           0.218          -0.232
## Correlation                   0.832           0.801           0.761
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.332           0.194           0.355
## Active Premium               -0.092           0.155          -0.290
## Information Ratio            -0.276           0.797          -0.815
## Treynor Ratio                -0.192          -0.069          -0.346
##                     X2628.HK to HSI X3328.HK to HSI X3988.HK to HSI
## Alpha                         0.000           0.000           0.000
## Beta                          1.361           1.357           1.159
## Beta+                         1.375           1.378           1.175
## Beta-                         1.255           1.343           1.094
## R-squared                     0.655           0.775           0.752
## Annualized Alpha             -0.034          -0.080          -0.078
## Correlation                   0.809           0.880           0.867
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.276           0.213           0.179
## Active Premium               -0.126          -0.146          -0.103
## Information Ratio            -0.457          -0.686          -0.575
## Treynor Ratio                -0.256          -0.272          -0.282
```

3 HSI Components Risk

3.1 Correlation

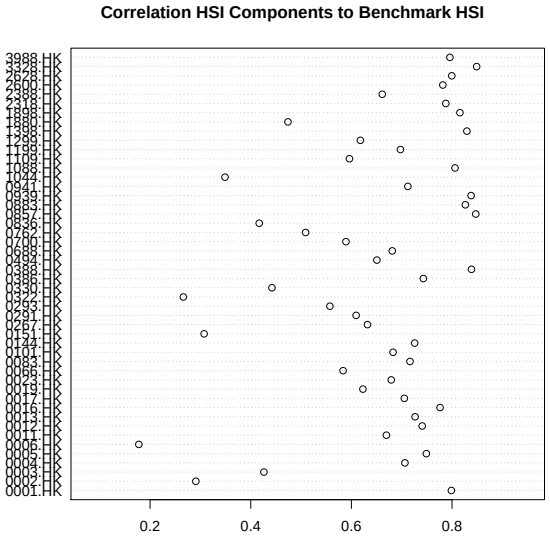
Correlation Combined

```
##                       Correlation p-value Lower CI Upper CI
## HSI Components to HSI      0.0056  0.9392  -0.1827   0.1936
```

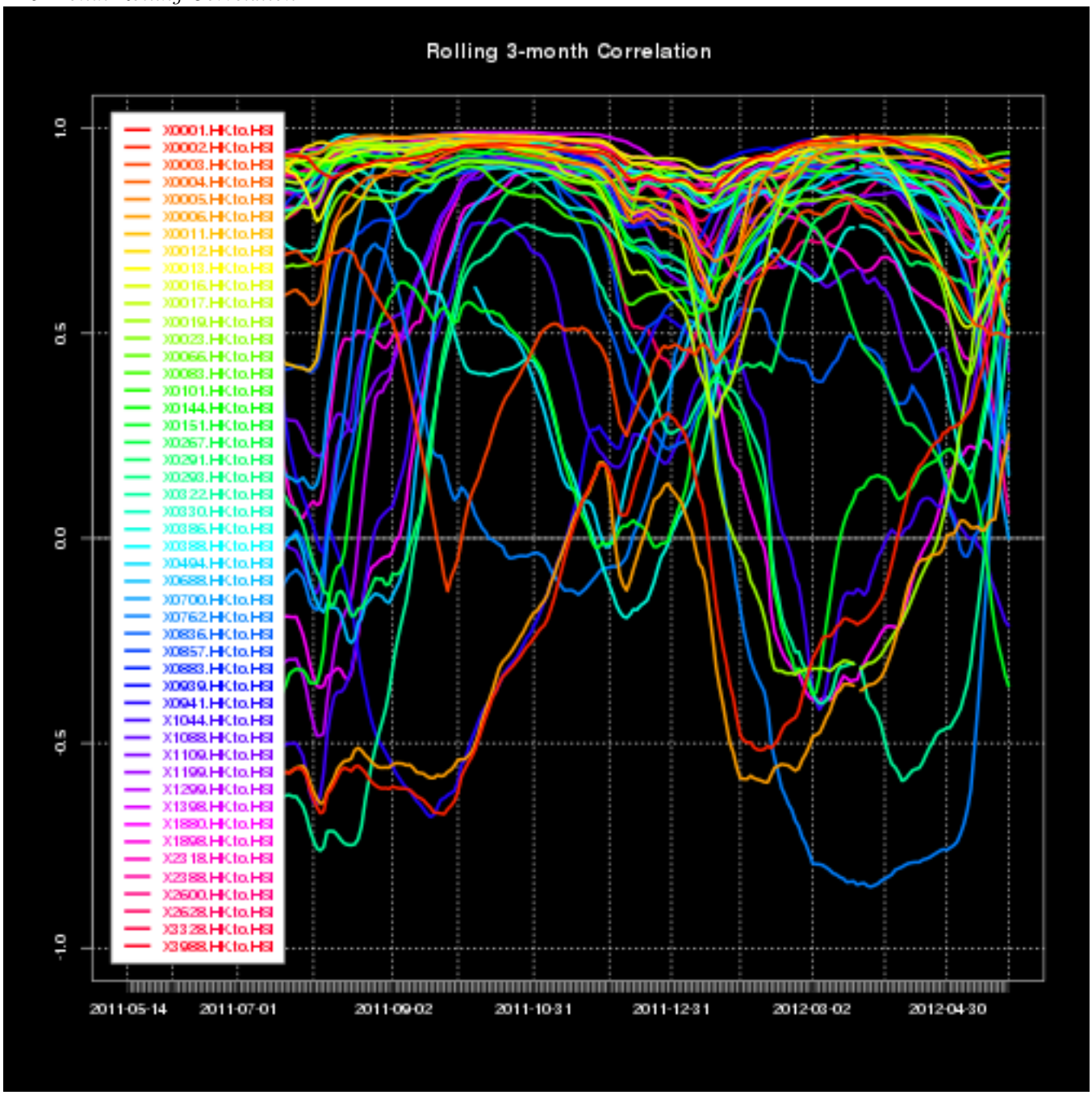
Correlation - Distinct

```
##         Correlation p-value Lower CI Upper CI
## 0001.HK      0.7987       0   0.7642   0.8287
## 0002.HK      0.2909       0   0.2076   0.3699
## 0003.HK      0.4262       0   0.3509   0.4961
## 0004.HK      0.7064       0   0.6591   0.7482
## 0005.HK      0.7490       0   0.7073   0.7855
## 0006.HK      0.1777       0   0.0905   0.2622
## 0011.HK      0.6696       0   0.6176   0.7157
## 0012.HK      0.7407       0   0.6979   0.7783
## 0013.HK      0.7266       0   0.6818   0.7659
## 0016.HK      0.7762       0   0.7384   0.8092
## 0017.HK      0.7052       0   0.6577   0.7472
## 0019.HK      0.6229       0   0.5655   0.6743
## 0023.HK      0.6792       0   0.6284   0.7242
## 0066.HK      0.5835       0   0.5218   0.6391
## 0083.HK      0.7165       0   0.6704   0.7570
## 0101.HK      0.6828       0   0.6324   0.7274
## 0144.HK      0.7258       0   0.6810   0.7652
## 0151.HK      0.3074       0   0.2249   0.3855
## 0267.HK      0.6320       0   0.5756   0.6824
## 0291.HK      0.6094       0   0.5505   0.6622
## 0293.HK      0.5573       0   0.4931   0.6156
## 0322.HK      0.2661       0   0.1817   0.3465
## 0330.HK      0.4422       0   0.3681   0.5108
## 0386.HK      0.7430       0   0.7005   0.7802
## 0388.HK      0.8386       0   0.8102   0.8631
## 0494.HK      0.6507       0   0.5446   0.7364
## 0688.HK      0.6812       0   0.6307   0.7260
## 0700.HK      0.5892       0   0.5282   0.6441
## 0762.HK      0.5091       0   0.4404   0.5718
## 0836.HK      0.4169       0   0.3408   0.4875
## 0857.HK      0.8472       0   0.8202   0.8705
## 0883.HK      0.8265       0   0.7963   0.8527
## 0939.HK      0.8379       0   0.8094   0.8625
## 0941.HK      0.7122       0   0.6656   0.7532
## 1044.HK      0.3489       0   0.2688   0.4242
## 1088.HK      0.8059       0   0.7725   0.8349
## 1109.HK      0.5962       0   0.5358   0.6504
## 1199.HK      0.6975       0   0.6490   0.7404
## 1299.HK      0.6178       0   0.5303   0.6923
## 1398.HK      0.8295       0   0.7997   0.8552
## 1880.HK      0.4740       0   0.4023   0.5400
## 1898.HK      0.8157       0   0.7837   0.8433
## 2318.HK      0.7877       0   0.7515   0.8191
## 2388.HK      0.6613       0   0.6084   0.7084
## 2600.HK      0.7817       0   0.7446   0.8139
## 2628.HK      0.7995       0   0.7651   0.8294
```

```
## 3328.HK      0.8489       0   0.8222   0.8720
## 3988.HK      0.7957       0   0.7607   0.8261
```



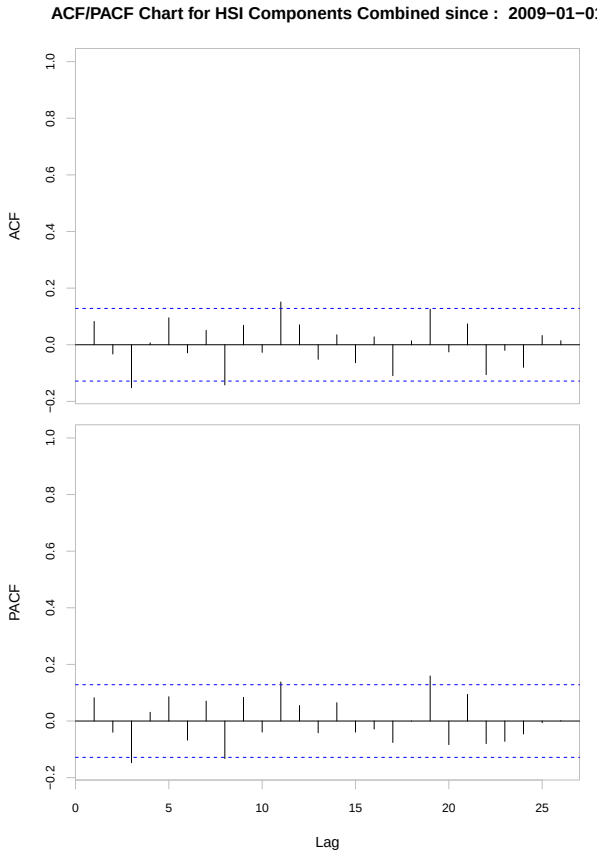
3 Month Rolling Correlation



3.2 Autocorrelation Coefficients - Combined

Autocorrelation Combined

```
##                  rho1    rho2    rho3   rho4   rho5    rho6 Q(6) p-value
## daily.returns 0.0824 -0.0326 -0.1519 0.0067 0.0953 -0.0286       0.1187
```



3.3 Downside Risk - Combined

Downside Risk Combined

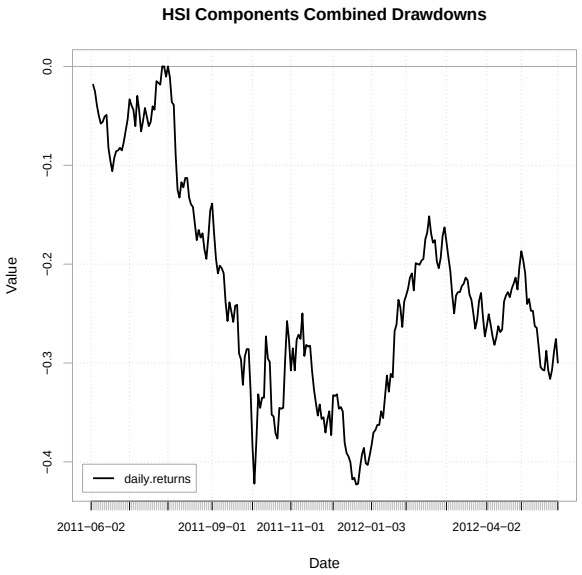
```
##                                HSI Components dailyReturn
## Semi Deviation                                      0.0241
## Gain Deviation                                      0.0178
## Loss Deviation                                      0.0157
## Downside Deviation (MAR=210%)                       0.0275
## Downside Deviation (Rf=0%)                          0.0247
## Downside Deviation (0%)                             0.0247
## Maximum Drawdown                                    0.4229
## Historical VaR (95%)                               -0.0370
## Historical ES (95%)                                -0.0538
## Modified VaR (95%)                                 -0.0393
## Modified ES (95%)                                  -0.0509
```

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    204        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%)           0.0247
```

3.6 Downside Deviation - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## Downside Deviation (MAR = 0%)  0.0191  0.0088  0.0152  0.0239  0.0247
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## Downside Deviation (MAR = 0%)   0.011  0.0147  0.0211  0.0189  0.0203
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## Downside Deviation (MAR = 0%)  0.0244  0.0206  0.0202  0.0129  0.0252
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## Downside Deviation (MAR = 0%)  0.0248  0.0265  0.0218  0.0246  0.0227
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## Downside Deviation (MAR = 0%)  0.0213  0.0204   0.035  0.0203  0.0193
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Downside Deviation (MAR = 0%)  0.0318  0.0257  0.0242  0.0228  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%)  0.0238  0.0287  0.0288  0.0195   0.021
##                                1880.HK 1898.HK 2318.HK 2388.HK 2600.HK
## Downside Deviation (MAR = 0%)  0.0268  0.0289  0.0264  0.0195  0.0293
##                                2628.HK 3328.HK 3988.HK
## Downside Deviation (MAR = 0%)   0.022  0.0221  0.0212
```

4 General Statistics

Statistics Distinct

```
##                Observations NAs Minimum Quartile 1  Median Arithmetic Mean
## X0001.HK.Close          844  12   56.00     91.700  98.500          100.213
## X0002.HK.Close          844  12   51.10     52.700  60.000           59.791
## X0003.HK.Close          844  12   10.78     17.280  18.260           17.757
## X0004.HK.Close          844  12   15.20     37.600  42.125           41.985
## X0005.HK.Close          843  13   33.00     66.300  77.050           74.365
## X0006.HK.Close          843  13   41.10     43.700  47.850           49.673
## X0011.HK.Close          844  12   67.00    102.500 109.500          108.998
## X0012.HK.Close          844  12   23.75     42.725  48.000           46.702
## X0013.HK.Close          843  13   36.40     53.400  61.300           64.895
## X0016.HK.Close          843  13   55.80     98.425 110.900          107.676
## X0017.HK.Close          843  13    6.20      9.350  13.240           12.447
## X0019.HK.Close          843  13   42.90     84.875  91.450           92.143
## X0023.HK.Close          844  12   12.34     26.938  29.000           28.269
## X0066.HK.Close          843  13   16.14     25.250  26.900           26.104
## X0083.HK.Close          843  13    5.60     11.910  13.500           13.056
## X0101.HK.Close          844  12   13.66     25.738  28.775           28.543
## X0144.HK.Close          843  13   12.20     23.225  26.200           25.913
## X0151.HK.Close          844  12    2.77      4.960   6.305            6.063
## X0267.HK.Close          844  12    7.18     13.800  16.790           16.745
## X0291.HK.Close          844  12   10.66     24.850  27.900           26.223
## X0293.HK.Close          843  13    6.98     12.660  14.660           15.069
## X0322.HK.Close          843  13    8.27     17.310  19.440           18.453
## X0330.HK.Close          844  12    7.93     22.738  41.475           37.245
## X0386.HK.Close          843  13    3.65      6.230   6.880            6.937
## X0388.HK.Close          844  12   54.60    122.800 134.900          135.941
## X0494.HK.Close          244 612   11.60     14.040  15.200           15.383
## X0688.HK.Close          844  12    9.41     14.380  15.540           15.251
## X0700.HK.Close          852   4   41.80    130.375 158.400          153.376
## X0762.HK.Close          851   5    8.31      9.830  11.160           11.999
## X0836.HK.Close          843  13   11.10     14.150  15.200           15.347
## X0857.HK.Close          844  12    5.10      8.750   9.490            9.452
## X0883.HK.Close          844  12    6.08     11.795  13.520           13.774
## X0939.HK.Close          843  13    3.66      5.625   6.220            6.105
## X0941.HK.Close          844  12   63.00     73.650  76.350           76.310
## X1044.HK.Close          856   0   24.25     50.237  60.925           57.765
## X1088.HK.Close          843  13   13.90     30.325  33.300           31.757
## X1109.HK.Close          843  13    7.50     13.050  14.480           14.371
## X1199.HK.Close          843  13    5.40      9.475  11.060           11.116
## X1299.HK.Close          390 466   19.86     23.000  24.625           24.919
## X1398.HK.Close          844  12    3.03      4.970   5.670            5.435
## X1880.HK.Close          844  12    2.98      8.405  12.630           11.263
## X1898.HK.Close          844  12    4.43      9.110  10.400           10.311
## X2318.HK.Close          843  13   30.35     58.425  64.350           65.118
## X2388.HK.Close          844  12    6.30     16.860  18.780           19.006
## X2600.HK.Close          843  13    3.17      4.380   6.820            6.434
## X2628.HK.Close          844  12   17.24     23.050  29.725           28.923
## X3328.HK.Close          844  12    4.17      5.930   7.880            7.449
## X3988.HK.Close          843  13    1.84      3.070   3.860            3.623
##                Geometric Mean Quartile 3 Maximum SE Mean LCL Mean (0.95)
## X0001.HK.Close         98.939    112.000  135.70  0.5398          99.153
## X0002.HK.Close         59.433     65.150   75.00  0.2281          59.343
## X0003.HK.Close         17.623     19.085   21.00  0.0716          17.617
## X0004.HK.Close         40.384     50.000   62.00  0.3672          41.265
```

```
## X0005.HK.Close          73.393     82.700   98.00  0.3958          73.588
## X0006.HK.Close          49.293     55.925   64.80  0.2166          49.248
## X0011.HK.Close         108.283    116.800  134.00  0.4212         108.171
## X0012.HK.Close          45.941     52.725   60.50  0.2740          46.164
## X0013.HK.Close          63.016     77.700   95.90  0.5403          63.835
## X0016.HK.Close         106.022    118.500  146.30  0.6120         106.475
## X0017.HK.Close          11.996     15.230   18.54  0.1140          12.223
## X0019.HK.Close          89.896    106.900  136.40  0.6622          90.843
## X0023.HK.Close          27.770     31.950   35.90  0.1681          27.939
## X0066.HK.Close          25.895     28.100   31.15  0.1083          25.892
## X0083.HK.Close          12.810     14.720   18.56  0.0829          12.893
## X0101.HK.Close          27.993     31.900   40.30  0.1854          28.180
## X0144.HK.Close          25.412     28.700   37.55  0.1682          25.582
## X0151.HK.Close           5.880      7.140    9.70  0.0532           5.958
## X0267.HK.Close          16.258     20.413   24.40  0.1369          16.477
## X0291.HK.Close          25.278     30.600   35.25  0.2175          25.796
## X0293.HK.Close          14.578     18.110   24.05  0.1350          14.804
## X0322.HK.Close          17.829     21.450   25.95  0.1528          18.154
## X0330.HK.Close          33.017     49.188   64.30  0.5344          36.196
## X0386.HK.Close           6.850      7.725    9.64  0.0391           6.860
## X0388.HK.Close         132.327    151.900  197.50  1.0005         133.977
## X0494.HK.Close          15.285     16.900   19.86  0.1153          15.156
## X0688.HK.Close          15.132     16.600   19.44  0.0651          15.123
## X0700.HK.Close         142.744    187.750  247.00  1.6867         150.066
## X0762.HK.Close          11.780     13.990   17.40  0.0841          11.834
## X0836.HK.Close          15.266     16.520   20.15  0.0564          15.237
## X0857.HK.Close           9.343     10.480   12.36  0.0495           9.355
## X0883.HK.Close          13.347     16.765   20.95  0.1170          13.544
## X0939.HK.Close           6.042      6.770    8.28  0.0312           6.044
## X0941.HK.Close          76.180     78.950   91.45  0.1548          76.006
## X1044.HK.Close          55.485     69.412   82.70  0.5067          56.771
## X1088.HK.Close          31.143     35.250   40.80  0.1943          31.376
## X1109.HK.Close          14.151     16.060   20.00  0.0861          14.202
## X1199.HK.Close          10.895     12.560   16.76  0.0784          10.962
## X1299.HK.Close          24.829     26.800   29.65  0.1097          24.704
## X1398.HK.Close           5.375      5.940    7.03  0.0287           5.379
## X1880.HK.Close          10.530     14.300   17.54  0.1300          11.008
## X1898.HK.Close          10.084     11.645   15.86  0.0741          10.166
## X2318.HK.Close          63.751     74.450   94.30  0.4465          64.241
## X2388.HK.Close          18.250     22.900   28.95  0.1723          18.668
## X2600.HK.Close           6.183      7.770   10.66  0.0637           6.309
## X2628.HK.Close          28.236     34.263   41.00  0.2145          28.502
## X3328.HK.Close           7.296      8.630   10.56  0.0537           7.343
## X3988.HK.Close           3.566      4.130    5.00  0.0240           3.576
##                 UCL Mean (0.95)  Variance   Stdev Skewness Kurtosis
## X0001.HK.Close          101.272  245.9706 15.6835  -0.1343   0.0292
## X0002.HK.Close           60.238   43.9107  6.6265   0.1905  -1.3829
## X0003.HK.Close           17.898    4.3283  2.0805  -1.6454   2.2874
## X0004.HK.Close           42.706  113.8083 10.6681  -0.5386   0.0296
## X0005.HK.Close           75.142  132.0540 11.4915  -0.6618   0.1633
## X0006.HK.Close           50.098   39.5409  6.2882   0.4201  -1.1837
## X0011.HK.Close          109.824  149.7354 12.2366  -0.4335   0.0846
## X0012.HK.Close           47.240   63.3762  7.9609  -0.8269   0.3192
## X0013.HK.Close           65.956  246.1151 15.6881   0.2156  -1.0581
## X0016.HK.Close          108.878  315.7254 17.7687  -0.7764   0.5528
## X0017.HK.Close           12.671   10.9604  3.3106  -0.3332  -1.1294
## X0019.HK.Close           93.443  369.6815 19.2271  -0.4060   0.1906
```

```
## X0023.HK.Close          28.599   23.8560  4.8843  -1.2957   1.4063
## X0066.HK.Close          26.317    9.8905  3.1449  -1.4687   1.6224
## X0083.HK.Close          13.218    5.7983  2.4080  -1.0362   0.9472
## X0101.HK.Close          28.907   29.0083  5.3859  -0.5123   0.1947
## X0144.HK.Close          26.243   23.8484  4.8835  -0.5161   0.5275
## X0151.HK.Close           6.167    2.3845  1.5442  -0.1885  -0.4867
## X0267.HK.Close          17.014   15.8210  3.9776  -0.2522  -0.8049
## X0291.HK.Close          26.650   39.9255  6.3187  -1.1072   0.1876
## X0293.HK.Close          15.334   15.3597  3.9191   0.1920  -0.5995
## X0322.HK.Close          18.753   19.6838  4.4366  -0.8987   0.0019
## X0330.HK.Close          38.294  241.0529 15.5259  -0.4622  -1.0238
## X0386.HK.Close           7.014    1.2901  1.1358  -0.3915   0.2874
## X0388.HK.Close         137.904  844.7695 29.0649  -0.5217   0.4500
## X0494.HK.Close          15.610    3.2419  1.8005   0.2000  -0.7305
## X0688.HK.Close          15.379    3.5796  1.8920  -0.8099   0.3350
## X0700.HK.Close         156.687 2423.9132 49.2333  -0.6628  -0.2548
## X0762.HK.Close          12.164    6.0179  2.4531   0.6037  -0.9834
## X0836.HK.Close          15.458    2.6799  1.6371   0.2661  -0.2544
## X0857.HK.Close           9.549    2.0682  1.4381  -0.7290   0.6015
## X0883.HK.Close          14.003   11.5559  3.3994  -0.2021  -0.7057
## X0939.HK.Close           6.166    0.8212  0.9062  -0.7200   0.1854
## X0941.HK.Close          76.614   20.2178  4.4964   0.1823   0.3308
## X1044.HK.Close          58.760  219.8122 14.8261  -0.7240  -0.4790
## X1088.HK.Close          32.138   31.8208  5.6410  -1.4512   1.7358
## X1109.HK.Close          14.540    6.2554  2.5011  -0.4097   0.0067
## X1199.HK.Close          11.270    5.1814  2.2763   0.0741  -0.3688
## X1299.HK.Close          25.135    4.6912  2.1659   0.0726  -1.1877
## X1398.HK.Close           5.491    0.6938  0.8329  -0.8839   0.4042
## X1880.HK.Close          11.518   14.2695  3.7775  -0.5741  -0.7848
## X1898.HK.Close          10.457    4.6284  2.1514  -0.3761   0.1891
## X2318.HK.Close          65.994  168.0585 12.9637  -0.1541  -0.1600
## X2388.HK.Close          19.344   25.0539  5.0054  -0.5467  -0.1004
## X2600.HK.Close           6.559    3.4192  1.8491  -0.2601  -1.0883
## X2628.HK.Close          29.344   38.8280  6.2312  -0.2088  -1.2060
## X3328.HK.Close           7.554    2.4361  1.5608  -0.2727  -1.1397
## X3988.HK.Close           3.670    0.4839  0.6956  -0.6451  -0.4875
```

4.1 Higher Moments - Combined

```
##                 HSI Components to HSI Combined
## CoSkewness                              0.0000
## CoKurtosis                              0.0000
## Beta CoVariance                         0.0087
## Beta CoSkewness                         1.1854
## Beta CoKurtosis                        -0.0616
```

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     5.0093 1.46873 1.21259 1.14321 1.06306 1.00361
## Proportion of Variance 0.5228 0.04494 0.03063 0.02723 0.02354 0.02098
## Cumulative Proportion  0.5228 0.56771 0.59834 0.62557 0.64912 0.67010
##                         Comp.7  Comp.8  Comp.9 Comp.10 Comp.11 Comp.12
## Standard deviation     0.96389 0.94653 0.90915 0.89579 0.85287 0.84175
## Proportion of Variance 0.01936 0.01866 0.01722 0.01672 0.01515 0.01476
## Cumulative Proportion  0.68946 0.70812 0.72534 0.74206 0.75721 0.77197
##                        Comp.13 Comp.14 Comp.15 Comp.16 Comp.17 Comp.18
## Standard deviation     0.80137 0.78313 0.76886 0.74208 0.72380 0.71258
## Proportion of Variance 0.01338 0.01278 0.01232 0.01147 0.01091 0.01058
## Cumulative Proportion  0.78535 0.79813 0.81044 0.82192 0.83283 0.84341
##                         Comp.19  Comp.20  Comp.21 Comp.22  Comp.23
## Standard deviation     0.687517 0.676823 0.652399 0.64099 0.630783
## Proportion of Variance 0.009847 0.009544 0.008867 0.00856 0.008289
## Cumulative Proportion  0.853257 0.862801 0.871668 0.88023 0.888517
##                         Comp.24  Comp.25  Comp.26  Comp.27  Comp.28
## Standard deviation     0.608459 0.599787 0.591759 0.582104 0.560152
## Proportion of Variance 0.007713 0.007495 0.007295 0.007059 0.006537
## Cumulative Proportion  0.896230 0.903725 0.911020 0.918080 0.924616
##                         Comp.29  Comp.30  Comp.31  Comp.32  Comp.33
## Standard deviation     0.540781 0.535934 0.501802 0.500668 0.492959
## Proportion of Variance 0.006093 0.005984 0.005246 0.005222 0.005063
## Cumulative Proportion  0.930709 0.936693 0.941939 0.947161 0.952224
##                         Comp.34  Comp.35  Comp.36  Comp.37  Comp.38
## Standard deviation     0.474594 0.467083 0.449698 0.444957 0.428462
## Proportion of Variance 0.004692 0.004545 0.004213 0.004125 0.003825
## Cumulative Proportion  0.956916 0.961461 0.965674 0.969799 0.973624
##                         Comp.39  Comp.40  Comp.41  Comp.42  Comp.43
## Standard deviation     0.414906 0.407670 0.389754 0.372910 0.371077
## Proportion of Variance 0.003586 0.003462 0.003165 0.002897 0.002869
## Cumulative Proportion  0.977210 0.980673 0.983837 0.986734 0.989603
##                         Comp.44  Comp.45  Comp.46  Comp.47  Comp.48
## Standard deviation     0.361065 0.337719 0.312393 0.285160 0.275172
## Proportion of Variance 0.002716 0.002376 0.002033 0.001694 0.001577
## Cumulative Proportion  0.992319 0.994695 0.996728 0.998423 1.000000
##
## Loadings:
##         Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8 Comp.9
## 0001.HK -0.175                -0.188
## 0002.HK         0.483         -0.124  0.166 -0.114  0.258 -0.150
## 0003.HK         0.355         -0.285 -0.138  0.167         0.239
## 0004.HK -0.164        -0.102 -0.117
## 0005.HK -0.171                                                  0.106
## 0006.HK         0.484          0.138  0.155         0.352        -0.213
## 0011.HK -0.157                -0.231        -0.106        -0.179  0.178
## 0012.HK -0.158        -0.143 -0.197                       0.244
## 0013.HK -0.169                -0.119        -0.138
## 0016.HK -0.154        -0.189 -0.200                       0.209
## 0017.HK -0.140        -0.191 -0.158                       0.150
## 0019.HK -0.121                -0.202         0.176 -0.287 -0.330 -0.252
## 0023.HK -0.149                -0.139  0.182                -0.248
## 0066.HK -0.136  0.161         -0.150         0.133        -0.205  0.184
## 0083.HK -0.154        -0.162 -0.144                       0.226 -0.110
```

```
## 0101.HK -0.155        -0.140               -0.148                0.150
## 0144.HK -0.151                0.177 -0.123 -0.115  0.157         0.159
## 0151.HK                0.497                0.222         0.305 -0.137
## 0267.HK -0.158                              0.115        -0.210
## 0291.HK -0.125                      -0.103         0.187  0.184 -0.222
## 0293.HK -0.127                             -0.173        -0.327 -0.286
## 0322.HK                0.489 -0.289  0.140         0.174
## 0330.HK                             -0.382  0.440  0.510 -0.207
## 0386.HK -0.132  0.223         0.311 -0.181        -0.302
## 0388.HK -0.170               -0.107         0.126
## 0494.HK -0.131                0.123         0.184  0.132         0.492
## 0688.HK -0.154 -0.189                0.111         0.138        -0.208
## 0700.HK -0.139                0.239  0.171 -0.228
## 0762.HK -0.130  0.163  0.203  0.186                -0.124  0.111
## 0836.HK                0.161        -0.657 -0.249        -0.136 -0.130
## 0857.HK -0.158  0.132         0.197 -0.135        -0.169
## 0883.HK -0.171                0.161
## 0939.HK -0.174
## 0941.HK -0.113  0.324  0.103                0.114 -0.151        -0.120
## 1044.HK -0.109         0.424         0.120                       0.128
## 1088.HK -0.170
## 1109.HK -0.149 -0.243                                           -0.208
## 1199.HK -0.159                0.167                0.153         0.153
## 1299.HK -0.134                                    -0.377                0.262
## 1398.HK -0.179                             0.132
## 1880.HK -0.128         0.169  0.134        -0.240  0.159        -0.123
## 1898.HK -0.167                              0.130        -0.171
## 2318.HK -0.168                      0.116  0.113 -0.116        -0.115
## 2388.HK -0.163                      0.188                -0.187
## 2600.HK -0.156                             0.123  0.108        -0.171
## 2628.HK -0.158                             0.191
## 3328.HK -0.175               0.113
## 3988.HK -0.171                             0.127
##         Comp.10 Comp.11 Comp.12 Comp.13 Comp.14 Comp.15 Comp.16 Comp.17
## 0001.HK                                                  0.131
## 0002.HK         -0.125                   0.150          -0.250
## 0003.HK  0.121   0.231                  -0.415   0.170
## 0004.HK         -0.122  -0.118                           0.123
## 0005.HK
## 0006.HK         -0.295   0.107          -0.179           0.303
## 0011.HK                 -0.120
## 0012.HK                                         -0.108           0.116
## 0013.HK  0.113                                           0.157
## 0016.HK  0.112  -0.159                   0.118
## 0017.HK  0.188  -0.163   0.241  -0.300   0.133  -0.132
## 0019.HK  0.342  -0.124          -0.125  -0.170  -0.120
## 0023.HK -0.110   0.140  -0.175   0.172  -0.111                  -0.207
## 0066.HK          0.147                   0.492           0.235  -0.119
## 0083.HK                                  0.220                   0.158
## 0101.HK                                 -0.218   0.135
## 0144.HK  0.133           0.130                                  -0.366
## 0151.HK  0.143  -0.303                                  0.100  -0.221
## 0267.HK         -0.124  -0.107           0.208          -0.102
## 0291.HK  0.138   0.360   0.175   0.550          -0.341  -0.128
## 0293.HK  0.325           0.216   0.249           0.246  -0.115   0.139
## 0322.HK -0.309           0.354                   0.305  -0.281
## 0330.HK          0.149  -0.203  -0.180                  -0.177   0.207
```

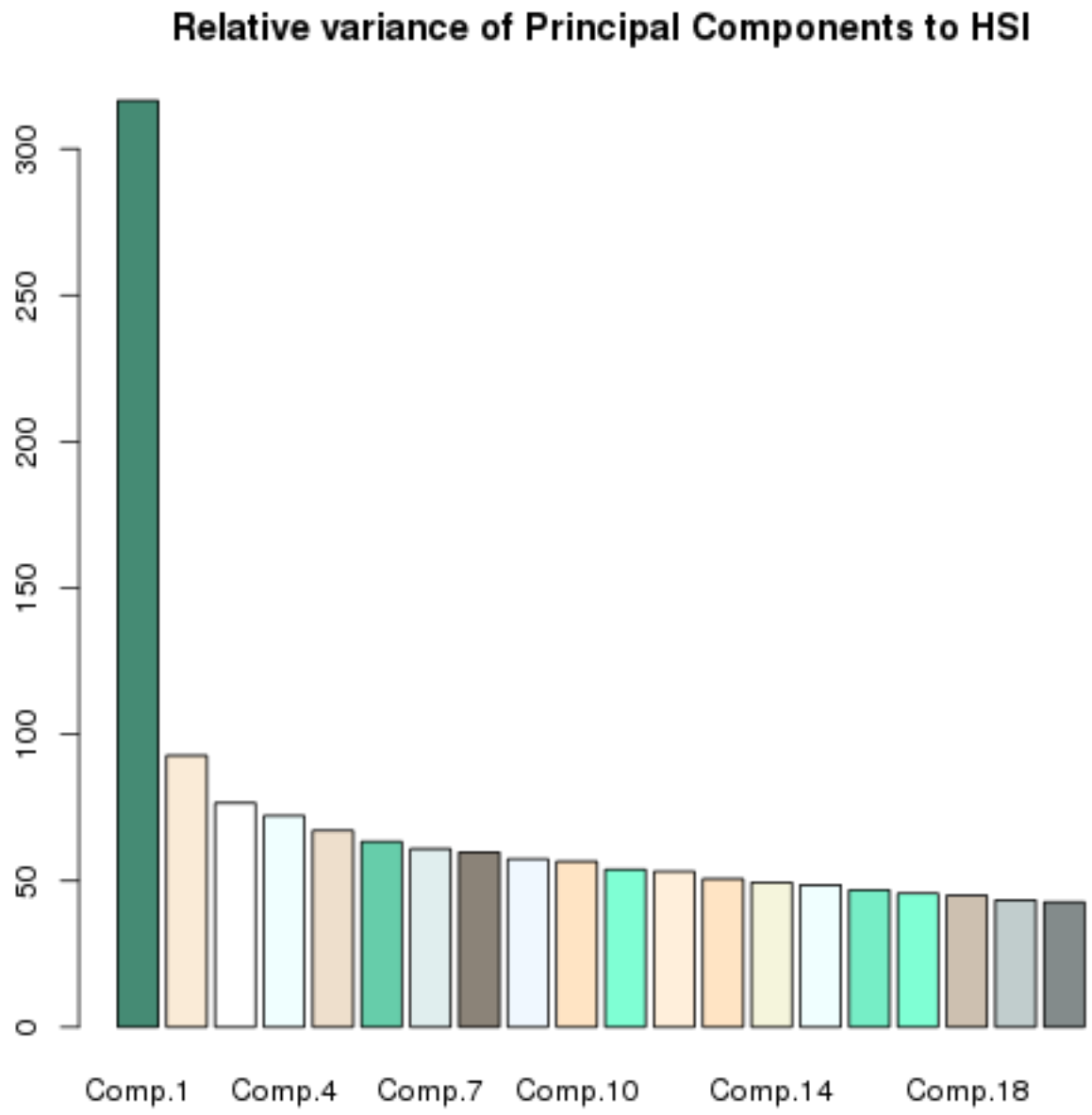
```
## 0386.HK                                                0.143  -0.126   0.194
## 0388.HK
## 0494.HK  0.193  -0.176          0.318  -0.217
## 0688.HK -0.172          -0.264                 0.187          -0.121
## 0700.HK                                 0.190   0.218
## 0762.HK         -0.164  -0.336                -0.314  -0.392  -0.127
## 0836.HK -0.358  -0.226                                 0.168
## 0857.HK                                                0.211  -0.216   0.164
## 0883.HK                                                       -0.223   0.106
## 0939.HK -0.120           0.220  -0.145          -0.173
## 0941.HK          0.355                  0.251   0.108   0.261  -0.184
## 1044.HK  0.168          -0.183                 -0.238   0.320   0.568
## 1088.HK                 -0.101          -0.142                 -0.199
## 1109.HK -0.194          -0.302          -0.105   0.131
## 1199.HK                  0.226           0.178                 -0.179
## 1299.HK          0.235  -0.144  -0.319          -0.172
## 1398.HK -0.167           0.171  -0.102          -0.123
## 1880.HK  0.318   0.287          -0.343           0.140
## 1898.HK                                 -0.110  -0.153
## 2318.HK                                                               0.105
## 2388.HK                         -0.149  -0.102  -0.111  -0.101
## 2600.HK                                                              -0.151
## 2628.HK -0.101                                         0.236           0.127
## 3328.HK                  0.160          -0.101           0.115
## 3988.HK -0.245   0.129   0.189                  -0.186
##         Comp.18 Comp.19 Comp.20 Comp.21 Comp.22 Comp.23 Comp.24 Comp.25
## 0001.HK                         -0.112           0.110
## 0002.HK                          0.125  -0.277
## 0003.HK -0.164   0.379  -0.136  -0.116                          0.252
## 0004.HK                          0.122                         -0.260
## 0005.HK -0.124   0.128   0.105  -0.170                 -0.183  -0.253
## 0006.HK  0.153                          0.133                  -0.129
## 0011.HK -0.145                   0.208   0.141  -0.115
## 0012.HK         -0.166  -0.152   0.166   0.144   0.136
## 0013.HK                  0.131                  0.128
## 0016.HK         -0.189          -0.248   0.229
## 0017.HK                                 -0.447                  0.219
## 0019.HK  0.371           0.115  -0.171          -0.217  -0.131
## 0023.HK -0.146  -0.153          -0.281                  -0.219
## 0066.HK          0.157  -0.168   0.217   0.141  -0.114
## 0083.HK                         -0.184   0.331
## 0101.HK         -0.331   0.123   0.326  -0.178  -0.212  -0.275
## 0144.HK                 -0.258  -0.125                  -0.195
## 0151.HK -0.284  -0.113                          -0.235   0.136  -0.176
## 0267.HK  0.140   0.151                          0.336           0.113
## 0291.HK  0.122   0.172   0.186
## 0293.HK -0.237  -0.153  -0.271          -0.151           0.322  -0.126
## 0322.HK  0.307                                                  0.124
## 0330.HK -0.114  -0.188   0.168
## 0386.HK  0.140          -0.124           0.153  -0.164           0.121
## 0388.HK          0.187           0.222                  0.203
## 0494.HK  0.145  -0.197                                  0.150   0.276   0.126
## 0688.HK                 -0.204  -0.134  -0.152                  0.155
## 0700.HK -0.229   0.146   0.470           0.164  -0.163           0.495
## 0762.HK                                 -0.117   0.273   0.191
## 0836.HK          0.136                          0.105
## 0857.HK                 -0.122                         -0.256
```

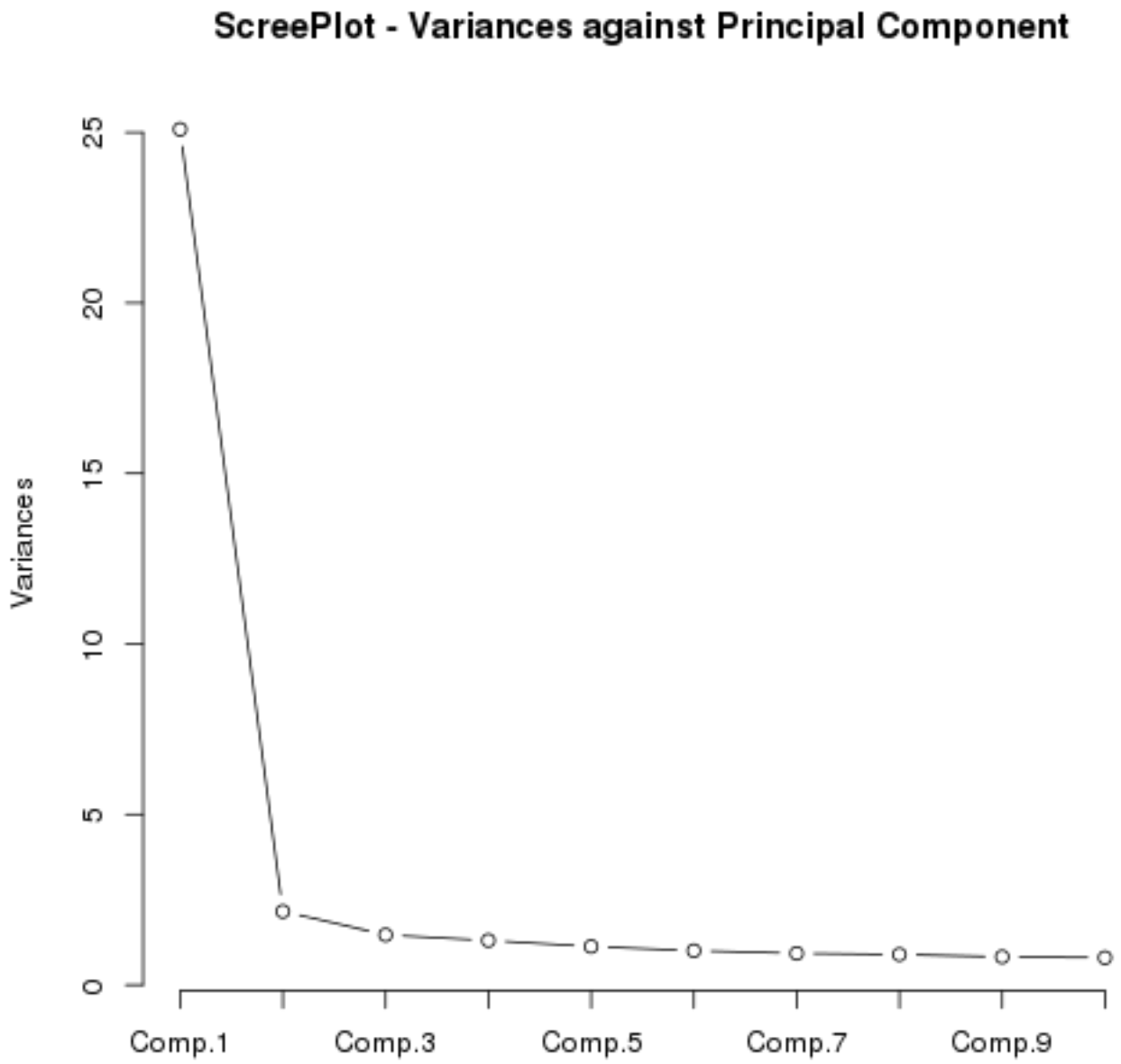
```
## 0883.HK -0.103          -0.149  -0.120                  -0.125
## 0939.HK -0.118  -0.121                                   0.115   0.135
## 0941.HK         -0.412   0.106          -0.223   0.124           0.137
## 1044.HK                 -0.135  -0.134  -0.164  -0.124  -0.169   0.118
## 1088.HK                  0.136                          -0.270  -0.143
## 1109.HK                 -0.247          -0.219
## 1199.HK          0.116  -0.105  -0.291
## 1299.HK  0.211                  -0.167          -0.301   0.437  -0.157
## 1398.HK
## 1880.HK  0.103                   0.331   0.178   0.331  -0.130  -0.215
## 1898.HK                                  0.124   0.129           0.144
## 2318.HK  0.132           0.211                   0.219   0.118  -0.113
## 2388.HK -0.266                                                   0.128
## 2600.HK  0.219   0.105  -0.203   0.247   0.158  -0.323   0.106
## 2628.HK  0.170   0.301   0.267          -0.230           0.112  -0.316
## 3328.HK -0.142                           0.120  -0.103
## 3988.HK -0.158  -0.117
##         Comp.26 Comp.27 Comp.28 Comp.29 Comp.30 Comp.31 Comp.32 Comp.33
## 0001.HK  0.129                                           -0.112   0.289
## 0002.HK  0.270   0.121  -0.130           0.105   0.271
## 0003.HK -0.174                   0.112   0.147
## 0004.HK         -0.263  -0.218   0.147   0.159  -0.358   0.457   0.140
## 0005.HK  0.132                  -0.133   0.119          -0.215
## 0006.HK                  0.137          -0.216  -0.238
## 0011.HK -0.131           0.208  -0.459  -0.261   0.187   0.112   0.259
## 0012.HK          0.269  -0.166   0.101           0.187           0.142
## 0013.HK  0.133  -0.140  -0.246          -0.126  -0.152  -0.487   0.173
## 0016.HK  0.277  -0.149          -0.338                          -0.148
## 0017.HK -0.117  -0.218   0.344  -0.106
## 0019.HK  0.119   0.223                   0.126  -0.107   0.122
## 0023.HK -0.173  -0.310   0.204           0.224                  -0.101
## 0066.HK  0.161   0.183   0.174   0.108          -0.264  -0.158
## 0083.HK -0.244   0.209   0.149                          -0.188  -0.200
## 0101.HK -0.116   0.165   0.109   0.200   0.115                  -0.204
## 0144.HK -0.289   0.199  -0.241                   0.100           0.261
## 0151.HK                          0.168  -0.236
## 0267.HK -0.307  -0.139           0.146  -0.331   0.184   0.138  -0.310
## 0291.HK                                 -0.228           0.166
## 0293.HK -0.197                                           -0.120
## 0322.HK                                          -0.158
## 0330.HK                                                          0.118
## 0386.HK         -0.120          -0.327          -0.127   0.103  -0.107
## 0388.HK                 -0.194           0.166  -0.193          -0.264
## 0494.HK  0.131   0.132   0.217
## 0688.HK  0.152   0.109   0.141
## 0700.HK                          0.115                          0.115
## 0762.HK -0.146           0.134           0.222  -0.202  -0.207
## 0836.HK  0.168                           0.136   0.120
## 0857.HK         -0.155           0.193  -0.262  -0.148
## 0883.HK  0.117           0.179   0.302                   0.162   0.203
## 0939.HK
## 0941.HK         -0.112  -0.131
## 1044.HK                          -0.120
## 1088.HK                 -0.373  -0.106  -0.140          -0.124  -0.342
## 1109.HK  0.145   0.107          -0.116          -0.185          -0.120
## 1199.HK  0.108                           0.222           0.126  -0.222
## 1299.HK                          0.189  -0.199
```

```
## 1398.HK                                                          0.201
## 1880.HK  0.129          0.199          0.168                           -0.138
## 1898.HK  0.266  -0.292          0.240          0.321  -0.195  -0.101
## 2318.HK -0.106   0.185  -0.132                          0.136   0.192
## 2388.HK  0.192         -0.161  -0.152  -0.260  -0.118
## 2600.HK -0.148  -0.373                  0.189   0.149  -0.207   0.224
## 2628.HK -0.137   0.117                          0.348
## 3328.HK                 0.159          0.141
## 3988.HK          0.169
##         Comp.34 Comp.35 Comp.36 Comp.37 Comp.38 Comp.39 Comp.40 Comp.41
## 0001.HK                                                  -0.146  -0.150
## 0002.HK  0.155   0.142  -0.228                  0.190
## 0003.HK         -0.104
## 0004.HK  0.121                                  -0.188  -0.151
## 0005.HK -0.209          0.100  -0.558                  -0.385  -0.136
## 0006.HK                 0.200  -0.108
## 0011.HK -0.179  -0.142  -0.144                  -0.297          0.247
## 0012.HK                 0.440  -0.137   0.314  -0.113          0.132
## 0013.HK         -0.119  -0.281                  0.215          0.193
## 0016.HK         -0.205   0.166          -0.272   0.173   0.189  -0.106
## 0017.HK  0.162                  0.121   0.237
## 0019.HK                 -0.144                  -0.187
## 0023.HK  0.147   0.261   0.119                  0.246   0.105
## 0066.HK  0.109  -0.145   0.155   0.134          0.105
## 0083.HK          0.373  -0.390   0.181                          -0.123
## 0101.HK -0.159  -0.129                  -0.430   0.111
## 0144.HK  0.260   0.223                  -0.324
## 0151.HK                                 -0.101                  0.169
## 0267.HK         -0.178          -0.258          0.191  -0.126
## 0291.HK                                 -0.111
## 0293.HK                 0.122
## 0322.HK
## 0330.HK
## 0386.HK  0.270   0.144                          0.185  -0.215   0.188
## 0388.HK          0.311          -0.318  -0.124  -0.223   0.153
## 0494.HK          0.149  -0.148          0.258   0.123          -0.168
## 0688.HK  0.115          -0.122                          -0.283
## 0700.HK                 0.144          0.101          0.101
## 0762.HK         -0.173                  -0.163
## 0836.HK -0.132   0.111                                  0.116  -0.137
## 0857.HK          0.182   0.171   0.153                  0.100
## 0883.HK         -0.118  -0.239                          0.349
## 0939.HK         -0.231  -0.193  -0.147                          -0.153
## 0941.HK -0.276          -0.109                  -0.161
## 1044.HK
## 1088.HK  0.125  -0.239  -0.121   0.159   0.368  -0.130          -0.201
## 1109.HK                                                  0.197   0.182
## 1199.HK -0.378  -0.182          0.214                          0.392
## 1299.HK                 0.153  -0.116   0.108
## 1398.HK                                         0.127          -0.174
## 1880.HK          0.107                                  0.103
## 1898.HK  0.169                          -0.143  -0.449  -0.202   0.187
## 2318.HK -0.127                  0.168          0.323  -0.145   0.352
## 2388.HK -0.315   0.270   0.241   0.279  -0.175                  -0.257
## 2600.HK -0.323                                  0.191          -0.212
## 2628.HK  0.166                  0.135  -0.189          0.267  -0.112
## 3328.HK  0.151  -0.146          0.259   0.161          -0.321  -0.121
```

```
## 3988.HK                          -0.123                    0.265   0.225
##         Comp.42 Comp.43 Comp.44 Comp.45 Comp.46 Comp.47 Comp.48
## 0001.HK  0.401                   0.349   0.437   0.394
## 0002.HK                         -0.125
## 0003.HK
## 0004.HK -0.118   0.266   0.156  -0.167
## 0005.HK -0.205           0.101  -0.111           0.111
## 0006.HK
## 0011.HK
## 0012.HK          0.206  -0.105   0.188          -0.193
## 0013.HK          0.220  -0.129          -0.317  -0.192  -0.114
## 0016.HK         -0.190          -0.259                   0.113
## 0017.HK -0.173
## 0019.HK  0.111
## 0023.HK                          0.244
## 0066.HK -0.166  -0.129
## 0083.HK
## 0101.HK
## 0144.HK
## 0151.HK
## 0267.HK  0.171   0.156          -0.131
## 0291.HK
## 0293.HK -0.137
## 0322.HK                 -0.107
## 0330.HK                          0.112
## 0386.HK -0.135   0.210           0.190   0.131
## 0388.HK  0.296  -0.349  -0.240                  -0.106
## 0494.HK
## 0688.HK                          0.104          -0.575
## 0700.HK
## 0762.HK                                                 -0.126
## 0836.HK
## 0857.HK  0.397  -0.184   0.305  -0.128  -0.200  -0.121
## 0883.HK -0.304          -0.455           0.100           0.165
## 0939.HK                  0.379   0.370  -0.376   0.151   0.344
## 0941.HK                 -0.165
## 1044.HK
## 1088.HK -0.162  -0.239                   0.205
## 1109.HK          0.112          -0.144  -0.156   0.519
## 1199.HK  0.156   0.150           0.220                  -0.101
## 1299.HK
## 1398.HK         -0.140                  -0.146          -0.808
## 1880.HK                  0.142
## 1898.HK -0.206           0.183
## 2318.HK -0.220  -0.454                                   0.149
## 2388.HK -0.127   0.246  -0.108                  -0.114
## 2600.HK
## 2628.HK          0.257           0.146
## 3328.HK  0.257          -0.461  -0.287  -0.254           0.246
## 3988.HK  0.126   0.210   0.194  -0.403   0.507  -0.117
##
##                Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8
## SS loadings     1.000  1.000  1.000  1.000  1.000  1.000  1.000  1.000
## Proportion Var  0.021  0.021  0.021  0.021  0.021  0.021  0.021  0.021
## Cumulative Var  0.021  0.042  0.063  0.083  0.104  0.125  0.146  0.167
##                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  0.021   0.021   0.021   0.021   0.021   0.021   0.021
## Cumulative Var  0.188   0.208   0.229   0.250   0.271   0.292   0.312
##                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   0.021   0.021   0.021   0.021   0.021   0.021   0.021
## Cumulative Var   0.333   0.354   0.375   0.396   0.417   0.438   0.458
##                Comp.23 Comp.24 Comp.25 Comp.26 Comp.27 Comp.28 Comp.29
## SS loadings      1.000   1.000   1.000   1.000   1.000   1.000   1.000
## Proportion Var   0.021   0.021   0.021   0.021   0.021   0.021   0.021
## Cumulative Var   0.479   0.500   0.521   0.542   0.562   0.583   0.604
##                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   0.021   0.021   0.021   0.021   0.021   0.021   0.021
## Cumulative Var   0.625   0.646   0.667   0.688   0.708   0.729   0.750
##                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   0.021   0.021   0.021   0.021   0.021   0.021   0.021
## Cumulative Var   0.771   0.792   0.812   0.833   0.854   0.875   0.896
##                Comp.44 Comp.45 Comp.46 Comp.47 Comp.48
## SS loadings      1.000   1.000   1.000   1.000   1.000
## Proportion Var   0.021   0.021   0.021   0.021   0.021
## Cumulative Var   0.917   0.938   0.958   0.979   1.000
```


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)

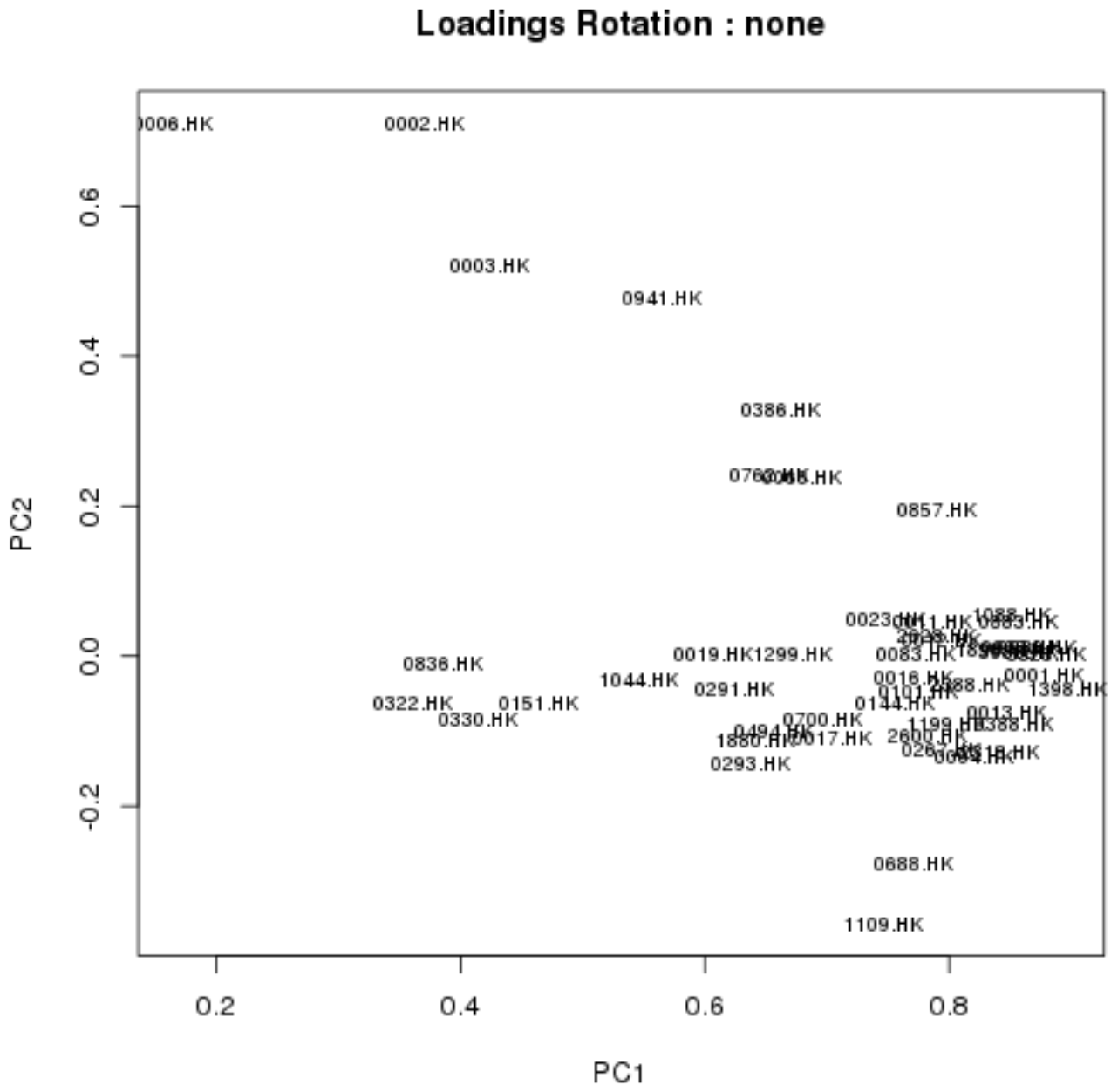
[7] http://en.wikipedia.org/wiki/Factoranalysis

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 0.90 -0.04 -0.02 -0.08 -0.14 0.83 0.17
## 3328.HK   47 0.88  0.00 -0.02 -0.13 -0.03 0.79 0.21
## 0001.HK    1 0.88 -0.02 -0.11  0.22  0.03 0.83 0.17
## 0939.HK   33 0.87  0.01  0.02 -0.07 -0.09 0.77 0.23
## 0005.HK    5 0.86  0.01 -0.07 -0.05 -0.02 0.74 0.26
## 3988.HK   48 0.86  0.01  0.01 -0.05 -0.08 0.74 0.26
## 0883.HK   32 0.86  0.04  0.02 -0.18 -0.02 0.77 0.23
## 0388.HK   25 0.85 -0.09 -0.11  0.12 -0.04 0.76 0.24
## 1088.HK   36 0.85  0.05  0.06 -0.11  0.04 0.74 0.26
## 0013.HK    9 0.85 -0.07 -0.07  0.14  0.10 0.76 0.24
## 2318.HK   43 0.84 -0.13 -0.09 -0.07 -0.12 0.75 0.25
## 1898.HK   42 0.84  0.01 -0.02 -0.09 -0.04 0.71 0.29
## 0004.HK    4 0.82 -0.13 -0.12  0.13  0.00 0.73 0.27
## 2388.HK   44 0.82 -0.04 -0.01  0.09 -0.20 0.72 0.28
## 1199.HK   38 0.80 -0.09 -0.09 -0.19  0.09 0.70 0.30
## 0012.HK    8 0.79  0.02 -0.17  0.23  0.04 0.71 0.29
## 0267.HK   19 0.79 -0.12  0.05  0.11  0.06 0.66 0.34
## 2628.HK   46 0.79  0.03 -0.07 -0.09 -0.07 0.64 0.36
## 0857.HK   31 0.79  0.19  0.00 -0.23  0.14 0.73 0.27
## 0011.HK    7 0.79  0.05 -0.03  0.26 -0.06 0.69 0.31
## 2600.HK   45 0.78 -0.11 -0.07 -0.10 -0.10 0.65 0.35
## 0101.HK   16 0.78 -0.05 -0.17  0.06  0.10 0.65 0.35
## 0083.HK   15 0.77  0.00 -0.20  0.16  0.03 0.67 0.33
## 0016.HK   10 0.77 -0.03 -0.23  0.23 -0.04 0.70 0.30
## 0688.HK   27 0.77 -0.28 -0.06 -0.10 -0.12 0.70 0.30
## 0144.HK   17 0.76 -0.06  0.05 -0.20  0.13 0.64 0.36
## 0023.HK   13 0.75  0.05  0.10  0.16 -0.19 0.63 0.37
## 1109.HK   37 0.75 -0.36 -0.04 -0.09 -0.07 0.70 0.30
## 0017.HK   11 0.70 -0.11 -0.23  0.18  0.08 0.60 0.40
## 0700.HK   28 0.70 -0.08  0.03 -0.27 -0.18 0.60 0.40
## 0066.HK   14 0.68  0.24  0.05  0.17  0.08 0.56 0.44
## 1299.HK   39 0.67  0.00  0.03  0.07  0.07 0.46 0.54
## 0386.HK   24 0.66  0.33 -0.05 -0.36  0.19 0.71 0.29
## 0494.HK   26 0.66 -0.10  0.02 -0.14 -0.02 0.46 0.54
## 0762.HK   29 0.65  0.24  0.25 -0.21 -0.02 0.59 0.41
## 1880.HK   41 0.64 -0.11  0.21 -0.15 -0.03 0.49 0.51
## 0293.HK   21 0.64 -0.14  0.02  0.04  0.06 0.43 0.57
## 0291.HK   20 0.62 -0.04  0.04  0.03  0.11 0.41 0.59
## 0019.HK   12 0.61  0.00  0.08  0.23  0.00 0.43 0.57
## 0941.HK   34 0.57  0.48  0.12 -0.09  0.09 0.58 0.42
## 1044.HK   35 0.55 -0.03  0.51 -0.04 -0.13 0.58 0.42
## 0330.HK   23 0.42 -0.08  0.00 -0.11  0.41 0.36 0.64
## 0006.HK    6 0.17  0.71 -0.12 -0.16 -0.16 0.60 0.40
## 0002.HK    2 0.37  0.71 -0.03  0.14 -0.18 0.69 0.31
## 0003.HK    3 0.42  0.52 -0.02  0.33  0.15 0.58 0.42
## 0151.HK   18 0.46 -0.06  0.60  0.09  0.04 0.59 0.41
## 0322.HK   22 0.36 -0.06  0.59  0.33 -0.15 0.62 0.38
## 0836.HK   30 0.39 -0.01  0.20  0.06  0.70 0.68 0.32
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    25.09 2.16 1.47 1.31 1.13
```

```
## Proportion Var  0.52 0.04 0.03 0.03 0.02
## Cumulative Var  0.52 0.57 0.60 0.63 0.65
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  44.96 0.3
## The degrees of freedom for the model are 898  and the objective function was  7.27
##  0.3The number of observations was  244  with Chi Square =  1620  with prob <  4.1e-44
##  0.3
## Fit based upon off diagonal values = 1
##             PC1        PC2
## 0001.HK 0.8785 -0.0245588
## 0002.HK 0.3706  0.7098632
## 0003.HK 0.4247  0.5208813
## 0004.HK 0.8212 -0.1341420
## 0005.HK 0.8585  0.0121024
## 0006.HK 0.1655  0.7107725
## 0011.HK 0.7867  0.0454973
## 0012.HK 0.7937  0.0207164
## 0013.HK 0.8474 -0.0745122
## 0016.HK 0.7706 -0.0293119
## 0017.HK 0.7037 -0.1102909
## 0019.HK 0.6080  0.0009621
## 0023.HK 0.7482  0.0493360
## 0066.HK 0.6795  0.2370343
## 0083.HK 0.7738  0.0021430
## 0101.HK 0.7754 -0.0475546
## 0144.HK 0.7554 -0.0641151
## 0151.HK 0.4646 -0.0631087
## 0267.HK 0.7933 -0.1243293
## 0291.HK 0.6239 -0.0443238
## 0293.HK 0.6376 -0.1435171
## 0322.HK 0.3607 -0.0614650
## 0330.HK 0.4150 -0.0842557
## 0386.HK 0.6618  0.3276600
## 0388.HK 0.8527 -0.0921959
## 0494.HK 0.6573 -0.0996915
## 0688.HK 0.7704 -0.2777914
## 0700.HK 0.6969 -0.0835307
## 0762.HK 0.6534  0.2399852
## 0836.HK 0.3868 -0.0110848
## 0857.HK 0.7901  0.1942961
## 0883.HK 0.8569  0.0449580
## 0939.HK 0.8722  0.0122637
## 0941.HK 0.5657  0.4759394
## 1044.HK 0.5460 -0.0313517
## 1088.HK 0.8511  0.0549959
## 1109.HK 0.7456 -0.3570894
## 1199.HK 0.7971 -0.0916660
## 1299.HK 0.6728  0.0025474
## 1398.HK 0.8977 -0.0432448
## 1880.HK 0.6422 -0.1138726
## 1898.HK 0.8385  0.0099308
## 2318.HK 0.8413 -0.1273891
## 2388.HK 0.8178 -0.0373977
## 2600.HK 0.7834 -0.1077000
## 2628.HK 0.7909  0.0285440
```

```
## 3328.HK 0.8791  0.0010755
## 3988.HK 0.8574  0.0058572
```



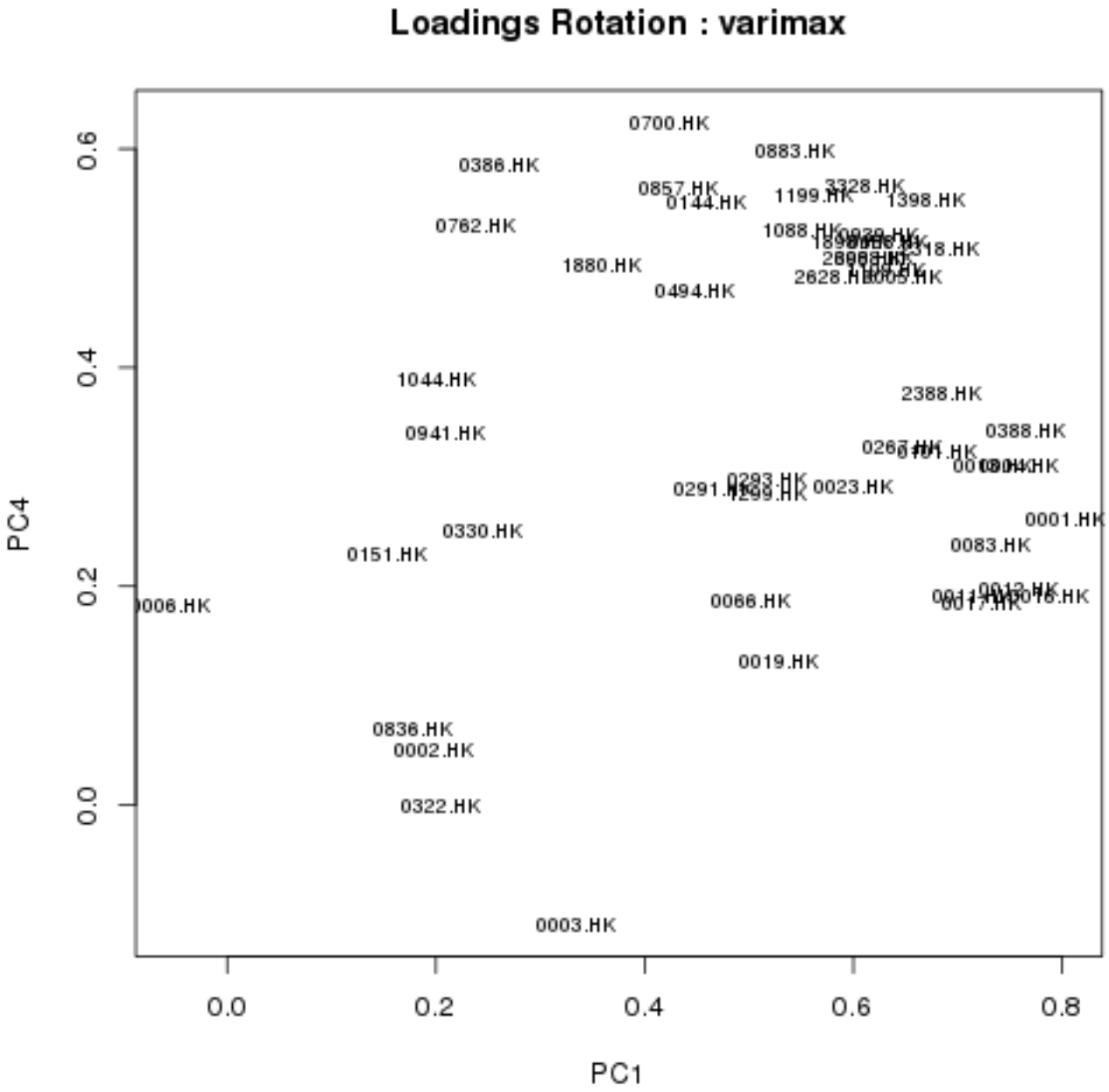
5.2.2 Rotation : varimax

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  0.80  0.26  0.20  0.20  0.19 0.83 0.17
## 0016.HK   10  0.79  0.19  0.18  0.08  0.09 0.70 0.30
## 0388.HK   25  0.76  0.34  0.13  0.18  0.12 0.76 0.24
## 0012.HK    8  0.76  0.20  0.23  0.11  0.18 0.71 0.29
## 0004.HK    4  0.76  0.31  0.08  0.15  0.15 0.73 0.27
## 0013.HK    9  0.73  0.31  0.14  0.19  0.26 0.76 0.24
## 0083.HK   15  0.73  0.24  0.20  0.07  0.17 0.67 0.33
## 0017.HK   11  0.72  0.19  0.08  0.02  0.19 0.60 0.40
## 0011.HK    7  0.71  0.19  0.25  0.27  0.10 0.69 0.31
## 2388.HK   44  0.69  0.38  0.18  0.27 -0.03 0.72 0.28
## 2318.HK   43  0.68  0.51  0.08  0.14  0.04 0.75 0.25
## 0101.HK   16  0.68  0.32  0.14  0.05  0.24 0.65 0.35
## 1398.HK   40  0.67  0.55  0.17  0.22  0.05 0.83 0.17
## 0005.HK    5  0.65  0.48  0.21  0.15  0.16 0.74 0.26
## 0267.HK   19  0.65  0.33  0.07  0.29  0.23 0.66 0.34
## 0688.HK   27  0.63  0.52 -0.08  0.16  0.04 0.70 0.30
## 1109.HK   37  0.63  0.49 -0.17  0.17  0.08 0.70 0.30
## 0939.HK   33  0.62  0.52  0.22  0.24  0.10 0.77 0.23
## 3988.HK   48  0.62  0.50  0.21  0.23  0.11 0.74 0.26
## 3328.HK   47  0.61  0.57  0.20  0.18  0.15 0.79 0.21
## 2600.HK   45  0.61  0.50  0.08  0.13  0.06 0.65 0.35
## 0023.HK   13  0.60  0.29  0.24  0.36 -0.02 0.63 0.37
## 1898.HK   42  0.60  0.51  0.20  0.18  0.14 0.71 0.29
## 2628.HK   46  0.58  0.48  0.21  0.13  0.09 0.64 0.36
## 1199.HK   38  0.56  0.56  0.08  0.06  0.24 0.70 0.30
## 1088.HK   36  0.55  0.53  0.24  0.23  0.23 0.74 0.26
## 0019.HK   12  0.53  0.13  0.16  0.30  0.13 0.43 0.57
## 0293.HK   21  0.52  0.30  0.01  0.20  0.19 0.43 0.57
## 1299.HK   39  0.52  0.28  0.16  0.21  0.21 0.46 0.54
## 0066.HK   14  0.50  0.19  0.40  0.25  0.23 0.56 0.44
## 0291.HK   20  0.47  0.29  0.10  0.19  0.24 0.41 0.59
## 0700.HK   28  0.42  0.62  0.07  0.16 -0.02 0.60 0.40
## 0883.HK   32  0.54  0.60  0.23  0.18  0.17 0.77 0.23
## 0386.HK   24  0.26  0.59  0.44 -0.04  0.33 0.71 0.29
## 0857.HK   31  0.43  0.56  0.35  0.10  0.31 0.73 0.27
## 0144.HK   17  0.46  0.55  0.09  0.16  0.29 0.64 0.36
## 0762.HK   29  0.24  0.53  0.36  0.31  0.15 0.59 0.41
## 1880.HK   41  0.36  0.49  0.03  0.32  0.13 0.49 0.51
## 0494.HK   26  0.45  0.47  0.05  0.16  0.12 0.46 0.54
## 0002.HK    2  0.20  0.05  0.80  0.10 -0.09 0.69 0.31
## 0006.HK    6 -0.05  0.18  0.73 -0.13 -0.13 0.60 0.40
## 0003.HK    3  0.34 -0.11  0.62  0.13  0.23 0.58 0.42
## 0941.HK   34  0.21  0.34  0.58  0.18  0.23 0.58 0.42
## 0322.HK   22  0.21  0.00  0.04  0.76  0.00 0.62 0.38
## 0151.HK   18  0.15  0.23  0.03  0.69  0.21 0.59 0.41
## 1044.HK   35  0.20  0.39  0.09  0.61  0.06 0.58 0.42
```

```
## 0836.HK   30  0.18  0.07  0.04  0.18  0.78 0.68 0.32
## 0330.HK   23  0.25  0.25 -0.02  0.02  0.48 0.36 0.64
##
##                  PC1  PC4  PC2  PC3  PC5
## SS loadings    14.79 7.70 3.43 3.05 2.18
## Proportion Var  0.31 0.16 0.07 0.06 0.05
## Cumulative Var  0.31 0.47 0.54 0.60 0.65
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  44.96 0.3
## The degrees of freedom for the model are 898  and the objective function was  7.27
##  0.3The number of observations was  244  with Chi Square =  1620  with prob <  4.1e-44
##  0.3
## Fit based upon off diagonal values = 1
##              PC1        PC4
## 0001.HK  0.80406  0.2619828
## 0002.HK  0.19873  0.0497487
## 0003.HK  0.33523 -0.1091807
## 0004.HK  0.75925  0.3094120
## 0005.HK  0.64661  0.4835594
## 0006.HK -0.05325  0.1814192
## 0011.HK  0.71421  0.1908970
## 0012.HK  0.75963  0.1982091
## 0013.HK  0.73489  0.3096070
## 0016.HK  0.78658  0.1919674
## 0017.HK  0.72303  0.1854645
## 0019.HK  0.52917  0.1311880
## 0023.HK  0.59930  0.2902527
## 0066.HK  0.50111  0.1872581
## 0083.HK  0.73159  0.2384681
## 0101.HK  0.68088  0.3221028
## 0144.HK  0.45887  0.5508949
## 0151.HK  0.15322  0.2298639
## 0267.HK  0.64581  0.3268008
## 0291.HK  0.46571  0.2886187
## 0293.HK  0.51770  0.2973641
## 0322.HK  0.20548 -0.0008117
## 0330.HK  0.24505  0.2507183
## 0386.HK  0.25972  0.5857689
## 0388.HK  0.76453  0.3417146
## 0494.HK  0.44770  0.4703708
## 0688.HK  0.63299  0.5151417
## 0700.HK  0.42471  0.6240932
## 0762.HK  0.23833  0.5299450
## 0836.HK  0.17693  0.0691244
## 0857.HK  0.43238  0.5639537
## 0883.HK  0.54484  0.5986774
## 0939.HK  0.62454  0.5214085
## 0941.HK  0.20961  0.3404256
## 1044.HK  0.20139  0.3899342
## 1088.HK  0.55000  0.5262437
## 1109.HK  0.63041  0.4884229
## 1199.HK  0.56316  0.5572183
## 1299.HK  0.51656  0.2849756
## 1398.HK  0.66838  0.5540351
## 1880.HK  0.35989  0.4943858
```

```
## 1898.HK  0.59694  0.5139810
## 2318.HK  0.68179  0.5078941
## 2388.HK  0.68552  0.3773088
## 2600.HK  0.60906  0.5007040
## 2628.HK  0.58149  0.4828870
## 3328.HK  0.61094  0.5670192
## 3988.HK  0.62093  0.5002319
```



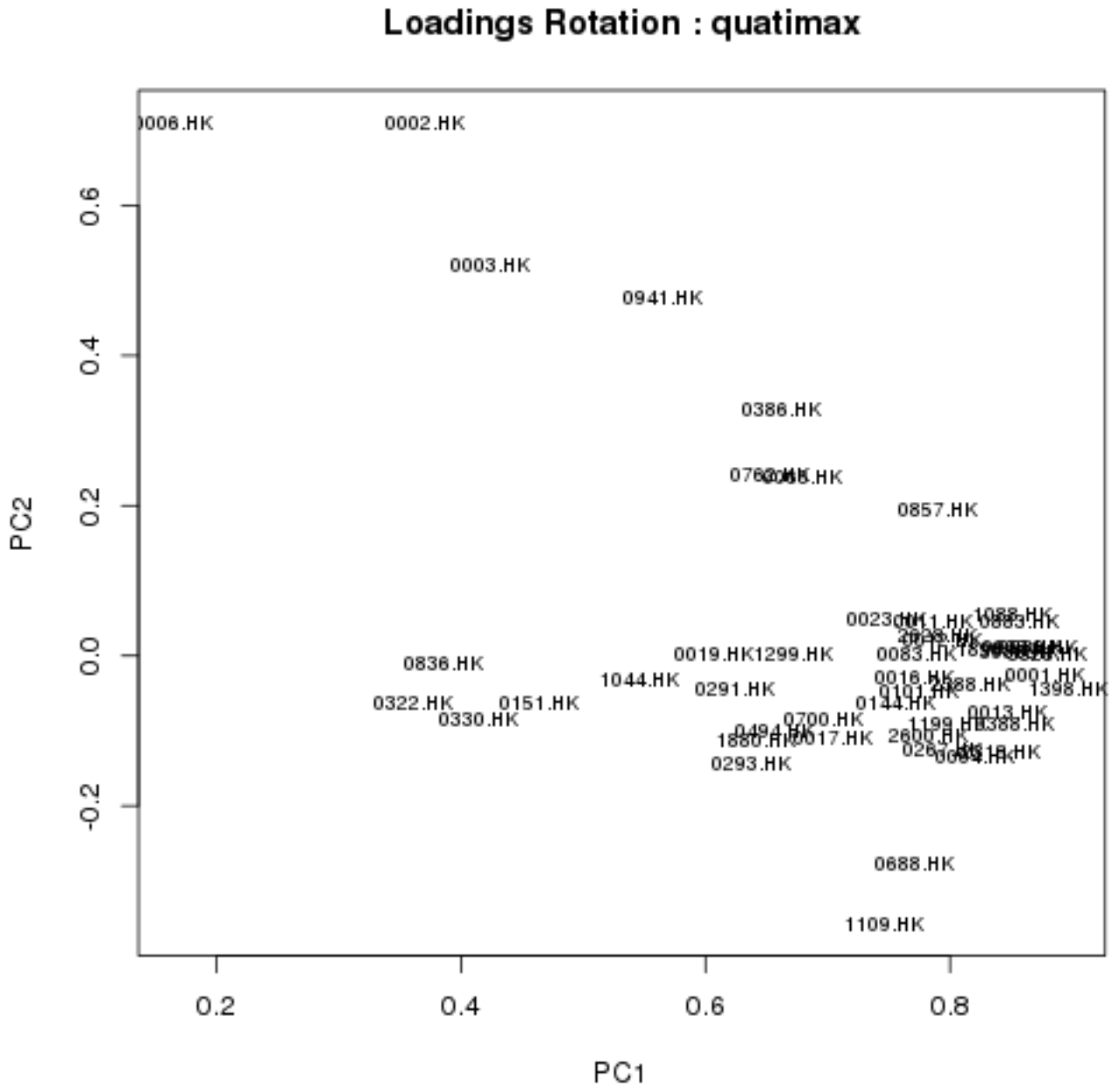
5.2.3 Rotation : quatimax

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 0.90 -0.04 -0.02 -0.08 -0.14 0.83 0.17
## 3328.HK   47 0.88  0.00 -0.02 -0.13 -0.03 0.79 0.21
## 0001.HK    1 0.88 -0.02 -0.11  0.22  0.03 0.83 0.17
## 0939.HK   33 0.87  0.01  0.02 -0.07 -0.09 0.77 0.23
## 0005.HK    5 0.86  0.01 -0.07 -0.05 -0.02 0.74 0.26
## 3988.HK   48 0.86  0.01  0.01 -0.05 -0.08 0.74 0.26
## 0883.HK   32 0.86  0.04  0.02 -0.18 -0.02 0.77 0.23
## 0388.HK   25 0.85 -0.09 -0.11  0.12 -0.04 0.76 0.24
## 1088.HK   36 0.85  0.05  0.06 -0.11  0.04 0.74 0.26
## 0013.HK    9 0.85 -0.07 -0.07  0.14  0.10 0.76 0.24
## 2318.HK   43 0.84 -0.13 -0.09 -0.07 -0.12 0.75 0.25
## 1898.HK   42 0.84  0.01 -0.02 -0.09 -0.04 0.71 0.29
## 0004.HK    4 0.82 -0.13 -0.12  0.13  0.00 0.73 0.27
## 2388.HK   44 0.82 -0.04 -0.01  0.09 -0.20 0.72 0.28
## 1199.HK   38 0.80 -0.09 -0.09 -0.19  0.09 0.70 0.30
## 0012.HK    8 0.79  0.02 -0.17  0.23  0.04 0.71 0.29
## 0267.HK   19 0.79 -0.12  0.05  0.11  0.06 0.66 0.34
## 2628.HK   46 0.79  0.03 -0.07 -0.09 -0.07 0.64 0.36
## 0857.HK   31 0.79  0.19  0.00 -0.23  0.14 0.73 0.27
## 0011.HK    7 0.79  0.05 -0.03  0.26 -0.06 0.69 0.31
## 2600.HK   45 0.78 -0.11 -0.07 -0.10 -0.10 0.65 0.35
## 0101.HK   16 0.78 -0.05 -0.17  0.06  0.10 0.65 0.35
## 0083.HK   15 0.77  0.00 -0.20  0.16  0.03 0.67 0.33
## 0016.HK   10 0.77 -0.03 -0.23  0.23 -0.04 0.70 0.30
## 0688.HK   27 0.77 -0.28 -0.06 -0.10 -0.12 0.70 0.30
## 0144.HK   17 0.76 -0.06  0.05 -0.20  0.13 0.64 0.36
## 0023.HK   13 0.75  0.05  0.10  0.16 -0.19 0.63 0.37
## 1109.HK   37 0.75 -0.36 -0.04 -0.09 -0.07 0.70 0.30
## 0017.HK   11 0.70 -0.11 -0.23  0.18  0.08 0.60 0.40
## 0700.HK   28 0.70 -0.08  0.03 -0.27 -0.18 0.60 0.40
## 0066.HK   14 0.68  0.24  0.05  0.17  0.08 0.56 0.44
## 1299.HK   39 0.67  0.00  0.03  0.07  0.07 0.46 0.54
## 0386.HK   24 0.66  0.33 -0.05 -0.36  0.19 0.71 0.29
## 0494.HK   26 0.66 -0.10  0.02 -0.14 -0.02 0.46 0.54
## 0762.HK   29 0.65  0.24  0.25 -0.21 -0.02 0.59 0.41
## 1880.HK   41 0.64 -0.11  0.21 -0.15 -0.03 0.49 0.51
## 0293.HK   21 0.64 -0.14  0.02  0.04  0.06 0.43 0.57
## 0291.HK   20 0.62 -0.04  0.04  0.03  0.11 0.41 0.59
## 0019.HK   12 0.61  0.00  0.08  0.23  0.00 0.43 0.57
## 0941.HK   34 0.57  0.48  0.12 -0.09  0.09 0.58 0.42
## 1044.HK   35 0.55 -0.03  0.51 -0.04 -0.13 0.58 0.42
## 0330.HK   23 0.42 -0.08  0.00 -0.11  0.41 0.36 0.64
## 0006.HK    6 0.17  0.71 -0.12 -0.16 -0.16 0.60 0.40
## 0002.HK    2 0.37  0.71 -0.03  0.14 -0.18 0.69 0.31
## 0003.HK    3 0.42  0.52 -0.02  0.33  0.15 0.58 0.42
## 0151.HK   18 0.46 -0.06  0.60  0.09  0.04 0.59 0.41
## 0322.HK   22 0.36 -0.06  0.59  0.33 -0.15 0.62 0.38
## 0836.HK   30 0.39 -0.01  0.20  0.06  0.70 0.68 0.32
```

```
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    25.09 2.16 1.47 1.31 1.13
## Proportion Var  0.52 0.04 0.03 0.03 0.02
## Cumulative Var  0.52 0.57 0.60 0.63 0.65
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  44.96 0.3
## The degrees of freedom for the model are 898  and the objective function was  7.27
##  0.3The number of observations was  244  with Chi Square =  1620  with prob <  4.1e-44
##  0.3
## Fit based upon off diagonal values = 1
##            PC1        PC2
## 0001.HK 0.8785 -0.0245588
## 0002.HK 0.3706  0.7098632
## 0003.HK 0.4247  0.5208813
## 0004.HK 0.8212 -0.1341420
## 0005.HK 0.8585  0.0121024
## 0006.HK 0.1655  0.7107725
## 0011.HK 0.7867  0.0454973
## 0012.HK 0.7937  0.0207164
## 0013.HK 0.8474 -0.0745122
## 0016.HK 0.7706 -0.0293119
## 0017.HK 0.7037 -0.1102909
## 0019.HK 0.6080  0.0009621
## 0023.HK 0.7482  0.0493360
## 0066.HK 0.6795  0.2370343
## 0083.HK 0.7738  0.0021430
## 0101.HK 0.7754 -0.0475546
## 0144.HK 0.7554 -0.0641151
## 0151.HK 0.4646 -0.0631087
## 0267.HK 0.7933 -0.1243293
## 0291.HK 0.6239 -0.0443238
## 0293.HK 0.6376 -0.1435171
## 0322.HK 0.3607 -0.0614650
## 0330.HK 0.4150 -0.0842557
## 0386.HK 0.6618  0.3276600
## 0388.HK 0.8527 -0.0921959
## 0494.HK 0.6573 -0.0996915
## 0688.HK 0.7704 -0.2777914
## 0700.HK 0.6969 -0.0835307
## 0762.HK 0.6534  0.2399852
## 0836.HK 0.3868 -0.0110848
## 0857.HK 0.7901  0.1942961
## 0883.HK 0.8569  0.0449580
## 0939.HK 0.8722  0.0122637
## 0941.HK 0.5657  0.4759394
## 1044.HK 0.5460 -0.0313517
## 1088.HK 0.8511  0.0549959
## 1109.HK 0.7456 -0.3570894
## 1199.HK 0.7971 -0.0916660
## 1299.HK 0.6728  0.0025474
## 1398.HK 0.8977 -0.0432448
## 1880.HK 0.6422 -0.1138726
## 1898.HK 0.8385  0.0099308
## 2318.HK 0.8413 -0.1273891
```

```
## 2388.HK 0.8178 -0.0373977
## 2600.HK 0.7834 -0.1077000
## 2628.HK 0.7909  0.0285440
## 3328.HK 0.8791  0.0010755
## 3988.HK 0.8574  0.0058572
```



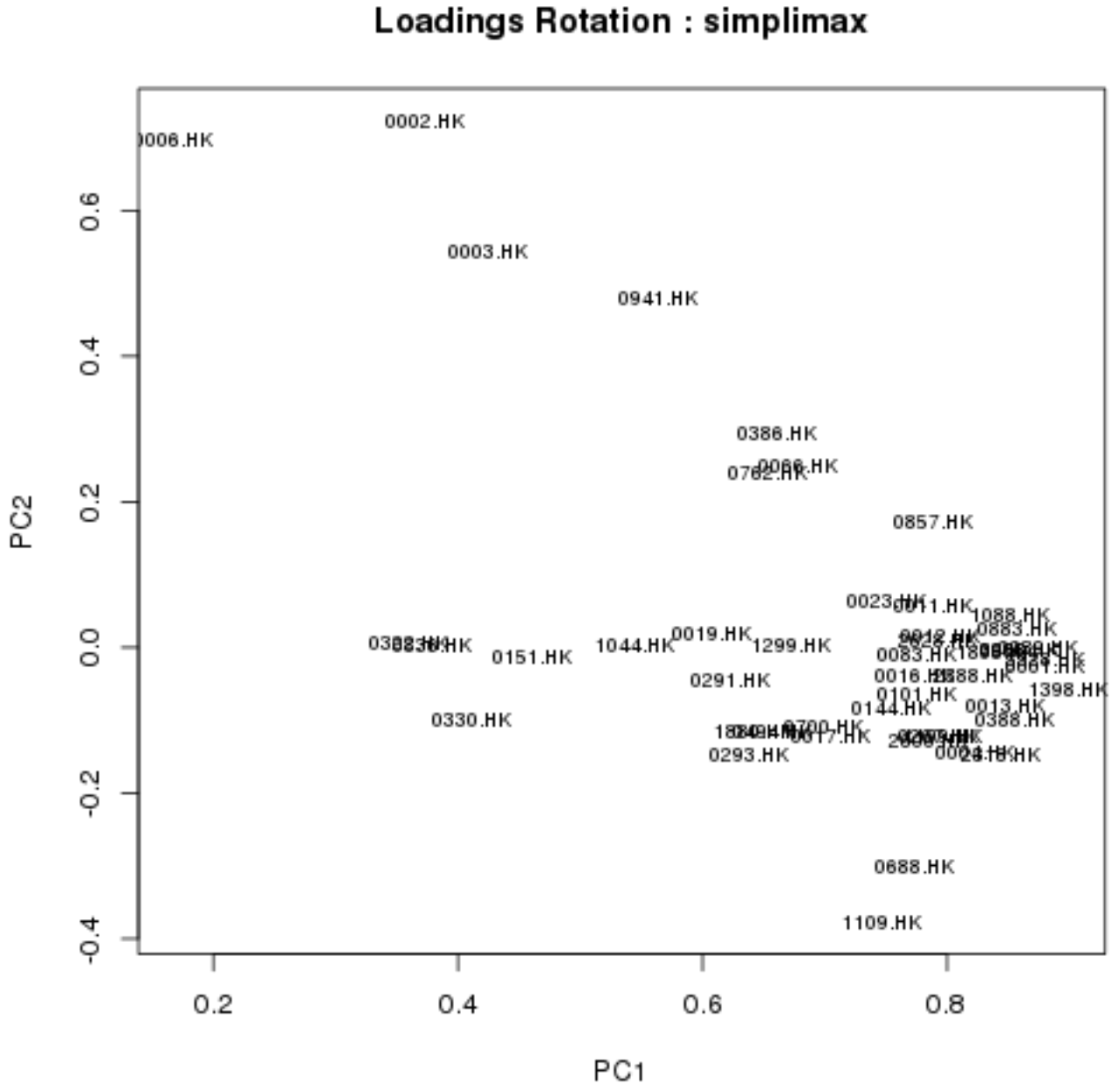
5.2.4 Rotation : simplimax

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   PC3   PC4   PC5   h2   u2
## 1398.HK   40 0.90 -0.06 -0.02  0.11 -0.11 0.83 0.17
## 3328.HK   47 0.88 -0.02 -0.02  0.17  0.00 0.79 0.21
## 0001.HK    1 0.88 -0.03 -0.10 -0.17  0.05 0.83 0.17
## 0939.HK   33 0.87  0.00  0.01  0.09 -0.06 0.77 0.23
## 0005.HK    5 0.86  0.00 -0.07  0.09  0.02 0.74 0.26
## 3988.HK   48 0.86  0.00  0.01  0.08 -0.05 0.74 0.26
## 0883.HK   32 0.86  0.03  0.01  0.22  0.02 0.77 0.23
## 0388.HK   25 0.85 -0.10 -0.10 -0.08 -0.02 0.76 0.24
## 1088.HK   36 0.85  0.04  0.06  0.14  0.07 0.74 0.26
## 0013.HK    9 0.85 -0.08 -0.07 -0.08  0.12 0.76 0.24
## 2318.HK   43 0.84 -0.15 -0.10  0.11 -0.09 0.75 0.25
## 1898.HK   42 0.84 -0.01 -0.02  0.12 -0.01 0.71 0.29
## 0004.HK    4 0.82 -0.14 -0.12 -0.08  0.03 0.73 0.27
## 2388.HK   44 0.82 -0.04  0.00 -0.08 -0.18 0.72 0.28
## 1199.HK   38 0.80 -0.12 -0.10  0.25  0.12 0.70 0.30
## 0012.HK    8 0.79  0.02 -0.16 -0.18  0.07 0.71 0.29
## 0267.HK   19 0.79 -0.12  0.06 -0.07  0.08 0.66 0.34
## 2628.HK   46 0.79  0.01 -0.07  0.12 -0.04 0.64 0.36
## 0857.HK   31 0.79  0.17 -0.01  0.26  0.18 0.73 0.27
## 0011.HK    7 0.79  0.06 -0.01 -0.24 -0.05 0.69 0.31
## 2600.HK   45 0.79 -0.13 -0.08  0.14 -0.07 0.65 0.35
## 0101.HK   16 0.78 -0.06 -0.17  0.00  0.13 0.65 0.35
## 0083.HK   15 0.78 -0.01 -0.19 -0.11  0.06 0.67 0.33
## 0016.HK   10 0.77 -0.04 -0.22 -0.18 -0.01 0.70 0.30
## 0688.HK   27 0.77 -0.30 -0.07  0.15 -0.09 0.70 0.30
## 0144.HK   17 0.75 -0.08  0.04  0.25  0.16 0.64 0.36
## 0023.HK   13 0.75  0.06  0.11 -0.16 -0.18 0.63 0.37
## 1109.HK   37 0.75 -0.38 -0.05  0.14 -0.05 0.70 0.30
## 0017.HK   11 0.70 -0.12 -0.23 -0.11  0.11 0.60 0.40
## 0700.HK   28 0.70 -0.11  0.02  0.29 -0.15 0.60 0.40
## 0066.HK   14 0.68  0.25  0.07 -0.16  0.10 0.56 0.44
## 1299.HK   39 0.67  0.00  0.04 -0.04  0.08 0.46 0.54
## 0386.HK   24 0.66  0.29 -0.06  0.39  0.24 0.71 0.29
## 0494.HK   26 0.66 -0.12  0.01  0.17  0.00 0.46 0.54
## 0762.HK   29 0.65  0.24  0.25  0.20 -0.01 0.59 0.41
## 1880.HK   41 0.64 -0.12  0.20  0.17 -0.02 0.49 0.51
## 0293.HK   21 0.64 -0.15  0.02  0.00  0.07 0.43 0.57
## 0291.HK   20 0.62 -0.05  0.04  0.00  0.12 0.41 0.59
## 0019.HK   12 0.61  0.02  0.09 -0.22  0.00 0.43 0.57
## 0941.HK   34 0.56  0.48  0.14  0.08  0.11 0.58 0.42
## 1044.HK   35 0.54  0.00  0.52  0.00 -0.14 0.58 0.42
## 0002.HK    2 0.37  0.72  0.00 -0.20 -0.16 0.69 0.31
## 0006.HK    6 0.17  0.70 -0.11  0.11 -0.13 0.60 0.40
## 0003.HK    3 0.42  0.54  0.01 -0.34  0.16 0.58 0.42
## 0322.HK   22 0.36  0.01  0.62 -0.39 -0.19 0.62 0.38
## 0151.HK   18 0.46 -0.01  0.61 -0.12  0.01 0.59 0.41
## 0330.HK   23 0.41 -0.10  0.00  0.17  0.42 0.36 0.64
## 0836.HK   30 0.38  0.00  0.20  0.00  0.70 0.68 0.32
##
```

```
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    25.08 2.16 1.47 1.30 1.14
## Proportion Var  0.52 0.05 0.03 0.03 0.02
## Cumulative Var  0.52 0.57 0.60 0.63 0.65
##
##  With component correlations of
##       PC1   PC2   PC3   PC4   PC5
## PC1  1.00  0.00  0.00 -0.04 -0.01
## PC2  0.00  1.00 -0.09  0.15 -0.03
## PC3  0.00 -0.09  1.00  0.12  0.05
## PC4 -0.04  0.15  0.12  1.00 -0.14
## PC5 -0.01 -0.03  0.05 -0.14  1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  44.96 0.3
## The degrees of freedom for the model are 898  and the objective function was  7.27
##  0.3The number of observations was  244  with Chi Square =  1620  with prob <  4.1e-44
##  0.3
## Fit based upon off diagonal values = 1
##            PC1       PC2
## 0001.HK 0.8796 -0.025433
## 0002.HK 0.3732  0.723396
## 0003.HK 0.4239  0.544511
## 0004.HK 0.8225 -0.142797
## 0005.HK 0.8597 -0.004421
## 0006.HK 0.1681  0.696779
## 0011.HK 0.7883  0.056637
## 0012.HK 0.7950  0.016588
## 0013.HK 0.8475 -0.078823
## 0016.HK 0.7731 -0.037516
## 0017.HK 0.7047 -0.123106
## 0019.HK 0.6082  0.018586
## 0023.HK 0.7505  0.063375
## 0066.HK 0.6790  0.250050
## 0083.HK 0.7753 -0.008211
## 0101.HK 0.7759 -0.064299
## 0144.HK 0.7541 -0.082958
## 0151.HK 0.4613 -0.014208
## 0267.HK 0.7930 -0.120858
## 0291.HK 0.6230 -0.045091
## 0293.HK 0.6373 -0.145845
## 0322.HK 0.3595  0.006125
## 0330.HK 0.4109 -0.097939
## 0386.HK 0.6604  0.294658
## 0388.HK 0.8545 -0.099934
## 0494.HK 0.6579 -0.115304
## 0688.HK 0.7725 -0.299374
## 0700.HK 0.6990 -0.107640
## 0762.HK 0.6527  0.240621
## 0836.HK 0.3786  0.002436
## 0857.HK 0.7891  0.172140
## 0883.HK 0.8575  0.025611
## 0939.HK 0.8738  0.001331
## 0941.HK 0.5646  0.478735
## 1044.HK 0.5449  0.001544
## 1088.HK 0.8510  0.044781
```

```
## 1109.HK 0.7471 -0.376910
## 1199.HK 0.7972 -0.121234
## 1299.HK 0.6725  0.003789
## 1398.HK 0.8999 -0.058509
## 1880.HK 0.6418 -0.115793
## 1898.HK 0.8396 -0.005369
## 2318.HK 0.8438 -0.147960
## 2388.HK 0.8206 -0.037940
## 2600.HK 0.7854 -0.128338
## 2628.HK 0.7925  0.010667
## 3328.HK 0.8801 -0.017321
## 3988.HK 0.8588 -0.004273
```



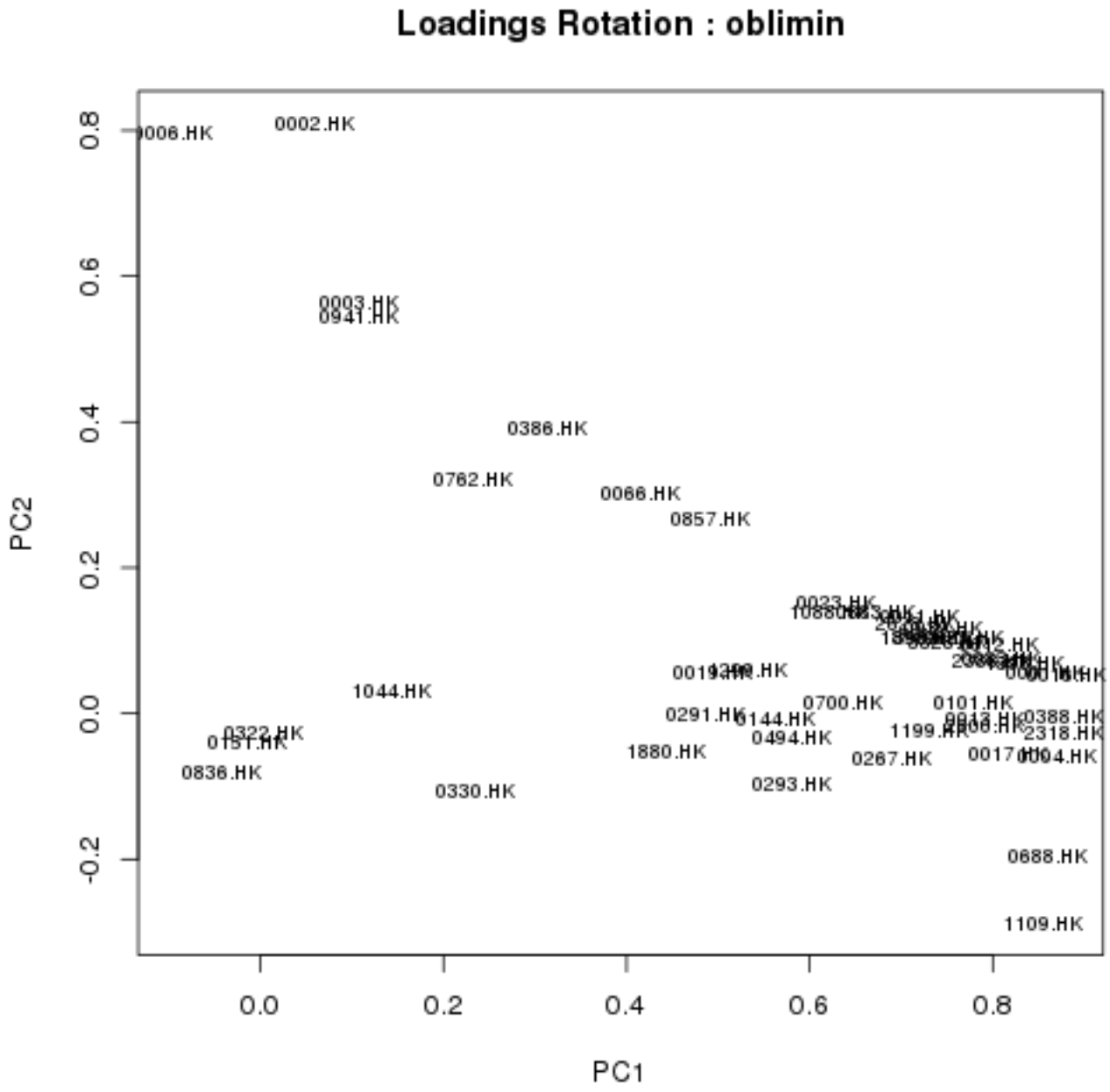
5.2.5 Rotation : oblimin

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  0.88  0.05 -0.10 -0.03 -0.23 0.70 0.30
## 0388.HK   25  0.88  0.00  0.02  0.00 -0.09 0.76 0.24
## 2318.HK   43  0.88 -0.03  0.01 -0.08  0.10 0.75 0.25
## 0004.HK    4  0.87 -0.06 -0.01  0.04 -0.11 0.73 0.27
## 0688.HK   27  0.86 -0.19  0.03 -0.08  0.14 0.70 0.30
## 0001.HK    1  0.86  0.06  0.03  0.08 -0.19 0.83 0.17
## 1109.HK   37  0.85 -0.29  0.04 -0.04  0.13 0.70 0.30
## 1398.HK   40  0.83  0.07  0.09 -0.07  0.13 0.83 0.17
## 0017.HK   11  0.82 -0.06 -0.15  0.09 -0.19 0.60 0.40
## 0083.HK   15  0.81  0.08 -0.09  0.06 -0.16 0.67 0.33
## 0012.HK    8  0.81  0.10 -0.06  0.07 -0.22 0.71 0.29
## 2388.HK   44  0.80  0.07  0.15 -0.15 -0.04 0.72 0.28
## 0013.HK    9  0.79 -0.01  0.03  0.16 -0.11 0.76 0.24
## 2600.HK   45  0.79 -0.02  0.01 -0.05  0.13 0.65 0.35
## 0101.HK   16  0.78  0.02 -0.10  0.14 -0.05 0.65 0.35
## 0005.HK    5  0.77  0.10  0.02  0.05  0.09 0.74 0.26
## 3328.HK   47  0.75  0.10  0.06  0.05  0.18 0.79 0.21
## 0939.HK   33  0.75  0.12  0.12 -0.01  0.12 0.77 0.23
## 3988.HK   48  0.73  0.11  0.11  0.00  0.10 0.74 0.26
## 1199.HK   38  0.73 -0.02 -0.07  0.15  0.21 0.70 0.30
## 0011.HK    7  0.72  0.13  0.13 -0.01 -0.22 0.69 0.31
## 1898.HK   42  0.72  0.10  0.06  0.04  0.14 0.71 0.29
## 2628.HK   46  0.72  0.12  0.01 -0.01  0.12 0.64 0.36
## 0267.HK   19  0.69 -0.06  0.16  0.14 -0.06 0.66 0.34
## 0883.HK   32  0.67  0.14  0.07  0.08  0.23 0.77 0.23
## 0700.HK   28  0.64  0.01  0.09 -0.12  0.33 0.60 0.40
## 0023.HK   13  0.63  0.15  0.27 -0.12 -0.09 0.63 0.37
## 1088.HK   36  0.62  0.14  0.13  0.15  0.16 0.74 0.26
## 0293.HK   21  0.58 -0.10  0.10  0.11 -0.01 0.43 0.57
## 0494.HK   26  0.58 -0.03  0.07  0.04  0.18 0.46 0.54
## 0144.HK   17  0.56 -0.01  0.07  0.23  0.24 0.64 0.36
## 1299.HK   39  0.53  0.06  0.11  0.14 -0.03 0.46 0.54
## 0019.HK   12  0.49  0.06  0.21  0.05 -0.18 0.43 0.57
## 0857.HK   31  0.49  0.27  0.00  0.26  0.26 0.73 0.27
## 0291.HK   20  0.49  0.00  0.10  0.18  0.00 0.41 0.59
## 1880.HK   41  0.44 -0.05  0.27  0.06  0.23 0.49 0.51
## 0066.HK   14  0.41  0.30  0.15  0.17 -0.13 0.56 0.44
## 0002.HK    2  0.06  0.81  0.07 -0.11 -0.12 0.69 0.31
## 0006.HK    6 -0.09  0.80 -0.12 -0.11  0.15 0.60 0.40
## 0003.HK    3  0.11  0.56  0.06  0.22 -0.32 0.58 0.42
## 0941.HK   34  0.11  0.54  0.15  0.22  0.14 0.58 0.42
## 0386.HK   24  0.31  0.39 -0.11  0.31  0.37 0.71 0.29
## 0762.HK   29  0.23  0.32  0.29  0.12  0.29 0.59 0.41
## 0322.HK   22  0.00 -0.03  0.79 -0.03 -0.20 0.62 0.38
## 0151.HK   18 -0.01 -0.04  0.72  0.19  0.04 0.59 0.41
## 1044.HK   35  0.14  0.03  0.63  0.01  0.16 0.58 0.42
## 0836.HK   30 -0.04 -0.08  0.12  0.82 -0.05 0.68 0.32
## 0330.HK   23  0.24 -0.11 -0.06  0.48  0.10 0.36 0.64
```

```
##
##                  PC1  PC2  PC3  PC5  PC4
## SS loadings    21.23 3.16 2.90 2.27 1.60
## Proportion Var  0.44 0.07 0.06 0.05 0.03
## Cumulative Var  0.44 0.51 0.57 0.62 0.65
##
##  With component correlations of
##      PC1  PC2  PC3  PC5  PC4
## PC1 1.00 0.35 0.46 0.42 0.18
## PC2 0.35 1.00 0.17 0.19 0.05
## PC3 0.46 0.17 1.00 0.21 0.10
## PC5 0.42 0.19 0.21 1.00 0.05
## PC4 0.18 0.05 0.10 0.05 1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  44.96 0.3
## The degrees of freedom for the model are 898  and the objective function was  7.27
##  0.3The number of observations was  244  with Chi Square =  1620  with prob <  4.1e-44
##  0.3
## Fit based upon off diagonal values = 1
##              PC1       PC2
## 0001.HK  0.85643  0.057448
## 0002.HK  0.05865  0.810203
## 0003.HK  0.10855  0.564864
## 0004.HK  0.87109 -0.058419
## 0005.HK  0.76840  0.104330
## 0006.HK -0.09444  0.795806
## 0011.HK  0.72045  0.132457
## 0012.HK  0.80654  0.096007
## 0013.HK  0.79215 -0.008253
## 0016.HK  0.88155  0.054327
## 0017.HK  0.81685 -0.055546
## 0019.HK  0.49328  0.057447
## 0023.HK  0.62819  0.151600
## 0066.HK  0.41424  0.302147
## 0083.HK  0.80906  0.076965
## 0101.HK  0.77780  0.015709
## 0144.HK  0.56228 -0.008424
## 0151.HK -0.01332 -0.040083
## 0267.HK  0.68921 -0.063187
## 0291.HK  0.48662 -0.001474
## 0293.HK  0.58099 -0.096827
## 0322.HK  0.00406 -0.025032
## 0330.HK  0.23521 -0.105778
## 0386.HK  0.31460  0.390649
## 0388.HK  0.87861 -0.004082
## 0494.HK  0.58053 -0.033362
## 0688.HK  0.86099 -0.194294
## 0700.HK  0.63562  0.013477
## 0762.HK  0.23272  0.320638
## 0836.HK -0.04182 -0.082246
## 0857.HK  0.49188  0.267054
## 0883.HK  0.67246  0.139214
## 0939.HK  0.74531  0.115628
## 0941.HK  0.10756  0.544888
## 1044.HK  0.14394  0.030388
```

```
## 1088.HK  0.62167  0.138343
## 1109.HK  0.85498 -0.287551
## 1199.HK  0.73053 -0.023565
## 1299.HK  0.53310  0.058784
## 1398.HK  0.83356  0.067897
## 1880.HK  0.44293 -0.051994
## 1898.HK  0.71968  0.102987
## 2318.HK  0.87831 -0.027672
## 2388.HK  0.79892  0.071576
## 2600.HK  0.79138 -0.016566
## 2628.HK  0.71600  0.123370
## 3328.HK  0.74985  0.097675
## 3988.HK  0.73484  0.105040
```



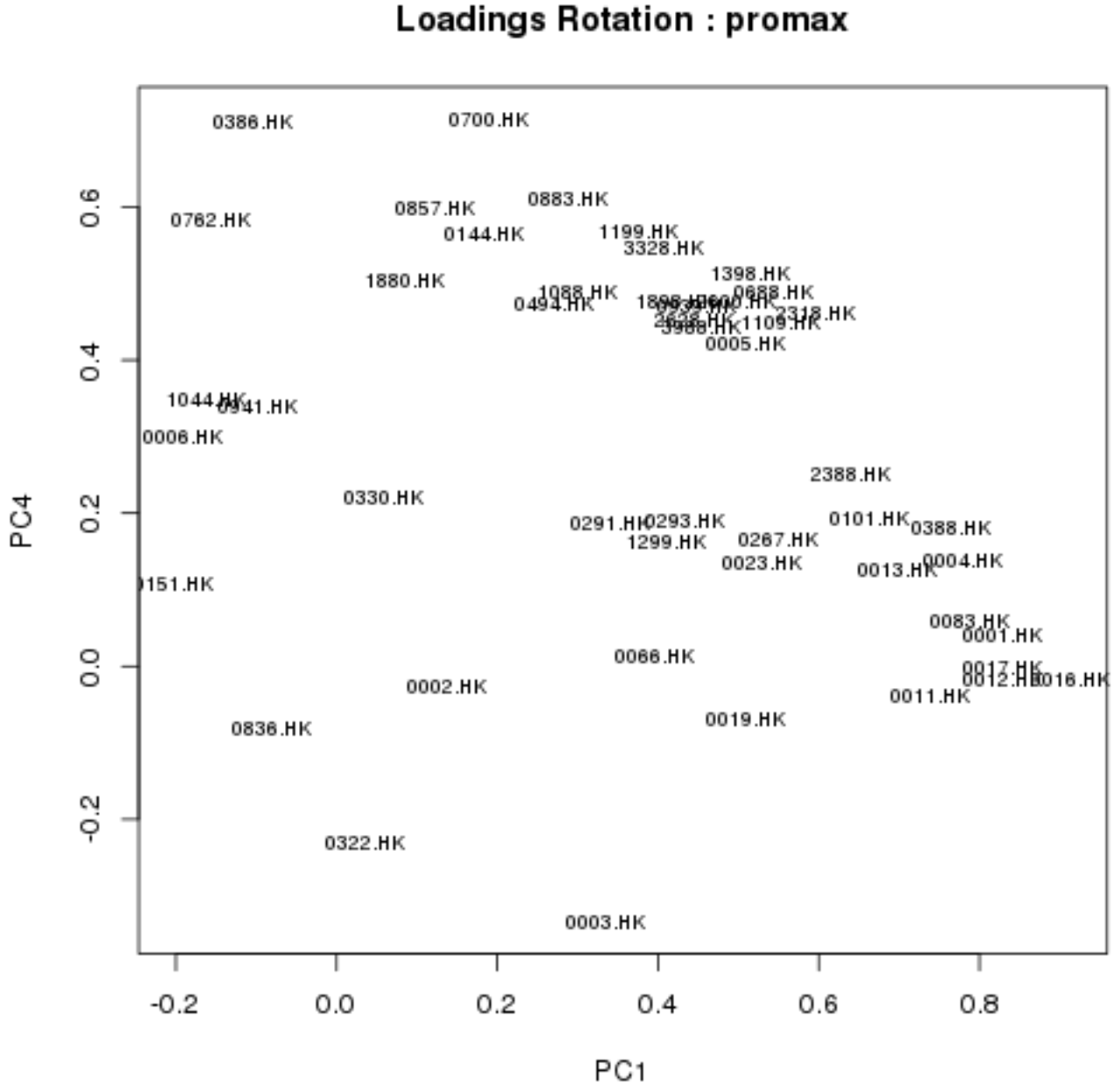
5.2.6 Rotation : promax

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  0.91 -0.02  0.06 -0.11 -0.06 0.70 0.30
## 0017.HK   11  0.83  0.00 -0.06 -0.16  0.08 0.60 0.40
## 0012.HK    8  0.83 -0.02  0.09 -0.07  0.05 0.71 0.29
## 0001.HK    1  0.83  0.04  0.05  0.01  0.05 0.83 0.17
## 0083.HK   15  0.79  0.06  0.07 -0.12  0.03 0.67 0.33
## 0004.HK    4  0.78  0.14 -0.07 -0.03  0.02 0.73 0.27
## 0388.HK   25  0.77  0.18 -0.02  0.00 -0.04 0.76 0.24
## 0011.HK    7  0.74 -0.04  0.14  0.13 -0.03 0.69 0.31
## 0013.HK    9  0.70  0.13 -0.03  0.01  0.14 0.76 0.24
## 0101.HK   16  0.66  0.19 -0.01 -0.14  0.12 0.65 0.35
## 2388.HK   44  0.64  0.25  0.07  0.13 -0.21 0.72 0.28
## 2318.HK   43  0.60  0.46 -0.06 -0.04 -0.14 0.75 0.25
## 1109.HK   37  0.55  0.45 -0.32  0.01 -0.07 0.70 0.30
## 0267.HK   19  0.55  0.16 -0.09  0.15  0.13 0.66 0.34
## 0688.HK   27  0.55  0.49 -0.23 -0.01 -0.13 0.70 0.30
## 0023.HK   13  0.53  0.13  0.15  0.26 -0.17 0.63 0.37
## 1398.HK   40  0.51  0.51  0.03  0.04 -0.14 0.83 0.17
## 0005.HK    5  0.51  0.42  0.07 -0.04  0.00 0.74 0.26
## 0019.HK   12  0.51 -0.07  0.06  0.22  0.05 0.43 0.57
## 2600.HK   45  0.50  0.48 -0.05 -0.04 -0.11 0.65 0.35
## 3988.HK   48  0.45  0.44  0.07  0.06 -0.06 0.74 0.26
## 0293.HK   21  0.43  0.19 -0.13  0.08  0.10 0.43 0.57
## 1299.HK   39  0.41  0.16  0.03  0.09  0.12 0.46 0.54
## 0066.HK   14  0.39  0.01  0.29  0.13  0.15 0.56 0.44
## 0291.HK   20  0.34  0.19 -0.04  0.08  0.17 0.41 0.59
## 0700.HK   28  0.19  0.71 -0.03  0.02 -0.20 0.60 0.40
## 0386.HK   24 -0.10  0.71  0.31 -0.22  0.23 0.71 0.29
## 0883.HK   32  0.29  0.61  0.08  0.00  0.01 0.77 0.23
## 0857.HK   31  0.12  0.60  0.20 -0.09  0.19 0.73 0.27
## 0762.HK   29 -0.16  0.58  0.26  0.23  0.05 0.59 0.41
## 1199.HK   38  0.38  0.57 -0.08 -0.14  0.11 0.70 0.30
## 0144.HK   17  0.18  0.56 -0.08  0.00  0.19 0.64 0.36
## 3328.HK   47  0.41  0.55  0.05 -0.01 -0.02 0.79 0.21
## 1880.HK   41  0.08  0.50 -0.11  0.23  0.03 0.49 0.51
## 1088.HK   36  0.30  0.49  0.08  0.07  0.09 0.74 0.26
## 1898.HK   42  0.42  0.48  0.06  0.00 -0.02 0.71 0.29
## 0494.HK   26  0.27  0.47 -0.08  0.02  0.00 0.46 0.54
## 0939.HK   33  0.45  0.47  0.08  0.06 -0.08 0.77 0.23
## 2628.HK   46  0.44  0.45  0.09 -0.05 -0.07 0.64 0.36
## 0002.HK    2  0.14 -0.03  0.84  0.04 -0.20 0.69 0.31
## 0006.HK    6 -0.19  0.30  0.80 -0.20 -0.23 0.60 0.40
## 0003.HK    3  0.34 -0.33  0.58  0.06  0.20 0.58 0.42
## 0941.HK   34 -0.10  0.34  0.50  0.09  0.15 0.58 0.42
## 0322.HK   22  0.04 -0.23 -0.02  0.87 -0.01 0.62 0.38
## 0151.HK   18 -0.20  0.11 -0.09  0.75  0.21 0.59 0.41
## 1044.HK   35 -0.16  0.35 -0.01  0.64 -0.01 0.58 0.42
## 0836.HK   30 -0.08 -0.08 -0.17  0.11  0.91 0.68 0.32
## 0330.HK   23  0.06  0.22 -0.18 -0.10  0.50 0.36 0.64
##
```

```
##                  PC1  PC4  PC2  PC3  PC5
## SS loadings    14.45 9.92 2.72 2.35 1.72
## Proportion Var  0.30 0.21 0.06 0.05 0.04
## Cumulative Var  0.30 0.51 0.56 0.61 0.65
##
##  With component correlations of
##      PC1  PC4  PC2  PC3  PC5
## PC1 1.00 0.71 0.35 0.56 0.53
## PC4 0.71 1.00 0.32 0.52 0.49
## PC2 0.35 0.32 1.00 0.25 0.38
## PC3 0.56 0.52 0.25 1.00 0.33
## PC5 0.53 0.49 0.38 0.33 1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  44.96 0.3
## The degrees of freedom for the model are 898  and the objective function was  7.27
##  0.3The number of observations was  244  with Chi Square =  1620  with prob <  4.1e-44
##  0.3
## Fit based upon off diagonal values = 1
##              PC1       PC4
## 0001.HK  0.82756  0.040459
## 0002.HK  0.13839 -0.025205
## 0003.HK  0.33524 -0.333699
## 0004.HK  0.77999  0.138779
## 0005.HK  0.50992  0.421277
## 0006.HK -0.18983  0.300473
## 0011.HK  0.73768 -0.038451
## 0012.HK  0.82850 -0.017134
## 0013.HK  0.69682  0.127160
## 0016.HK  0.91439 -0.016073
## 0017.HK  0.82891 -0.002402
## 0019.HK  0.50800 -0.069252
## 0023.HK  0.52965  0.134729
## 0066.HK  0.39462  0.014544
## 0083.HK  0.78787  0.060293
## 0101.HK  0.66366  0.193447
## 0144.HK  0.18389  0.564933
## 0151.HK -0.20164  0.107440
## 0267.HK  0.54886  0.164914
## 0291.HK  0.34192  0.187539
## 0293.HK  0.43367  0.189001
## 0322.HK  0.03520 -0.231241
## 0330.HK  0.05927  0.221717
## 0386.HK -0.10416  0.710303
## 0388.HK  0.76519  0.180219
## 0494.HK  0.27075  0.474637
## 0688.HK  0.54542  0.489271
## 0700.HK  0.19064  0.714848
## 0762.HK -0.15509  0.584273
## 0836.HK -0.08133 -0.081811
## 0857.HK  0.12187  0.598004
## 0883.HK  0.28870  0.610535
## 0939.HK  0.44752  0.470599
## 0941.HK -0.09753  0.338626
## 1044.HK -0.16278  0.349623
## 1088.HK  0.30084  0.488202
```

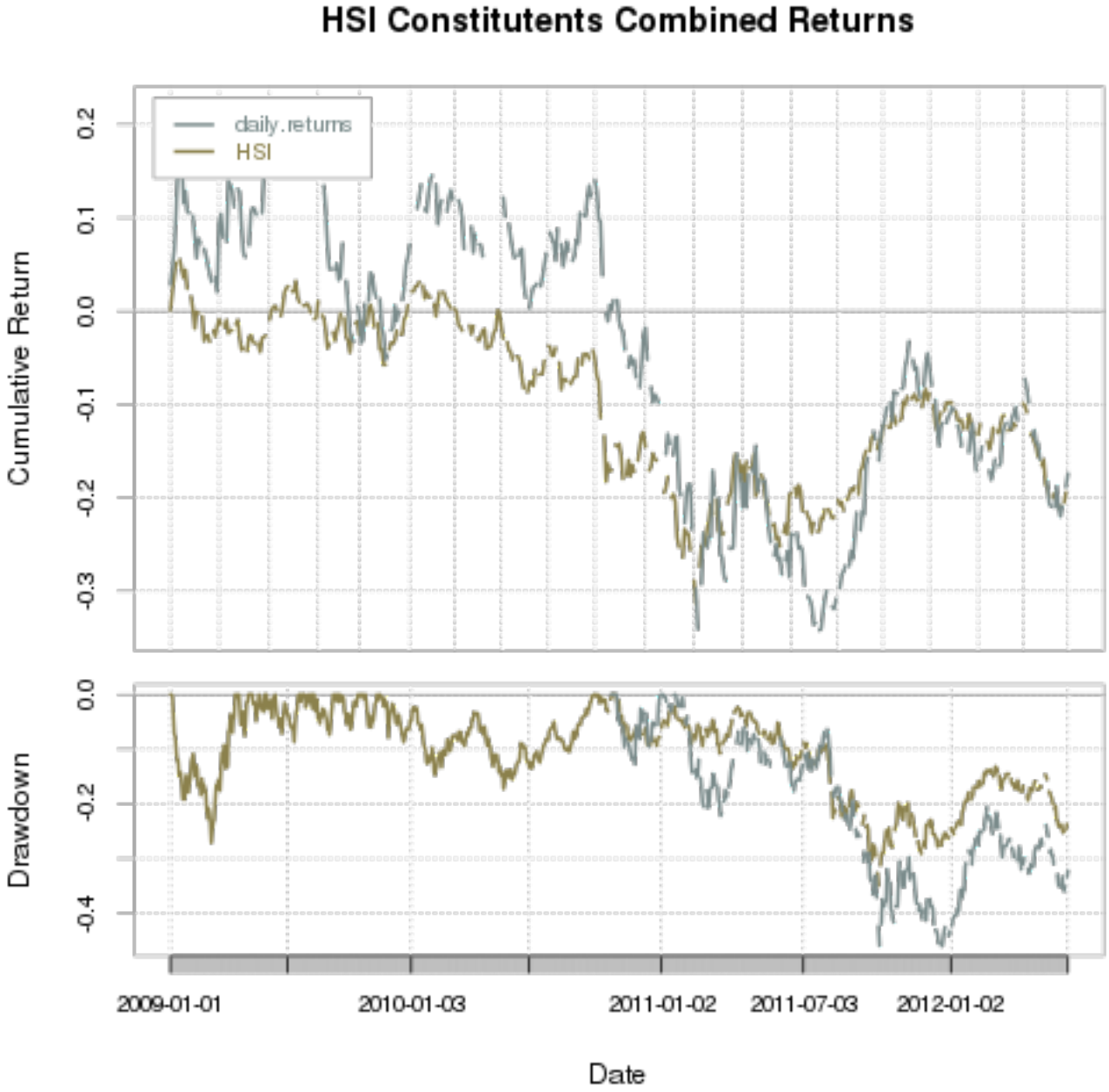
```
## 1109.HK  0.55291  0.447570
## 1199.HK  0.37519  0.567101
## 1299.HK  0.41011  0.163787
## 1398.HK  0.51487  0.511912
## 1880.HK  0.08356  0.503143
## 1898.HK  0.42107  0.476824
## 2318.HK  0.59701  0.460476
## 2388.HK  0.64059  0.251208
## 2600.HK  0.49899  0.475137
## 2628.HK  0.44471  0.452787
## 3328.HK  0.40731  0.546163
## 3988.HK  0.45380  0.441643
```



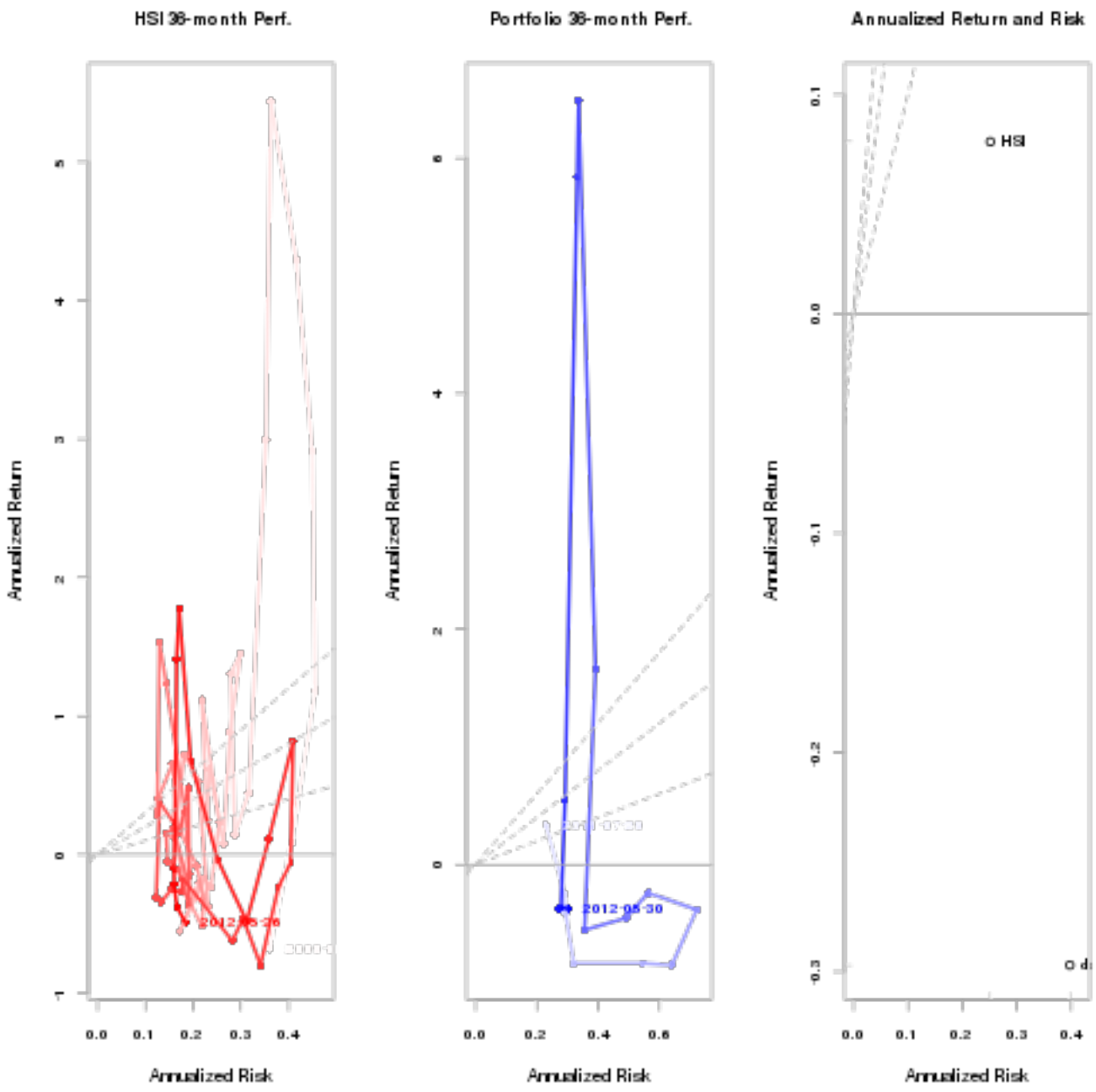
PCA is a science in itself and can not be fully covered and even less interpreted in this paper. The factors produced by principal component analysis are conceptualized as being linear combinations of the variables whereas the factors produced by common factor analysis are conceptualized as being latent 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

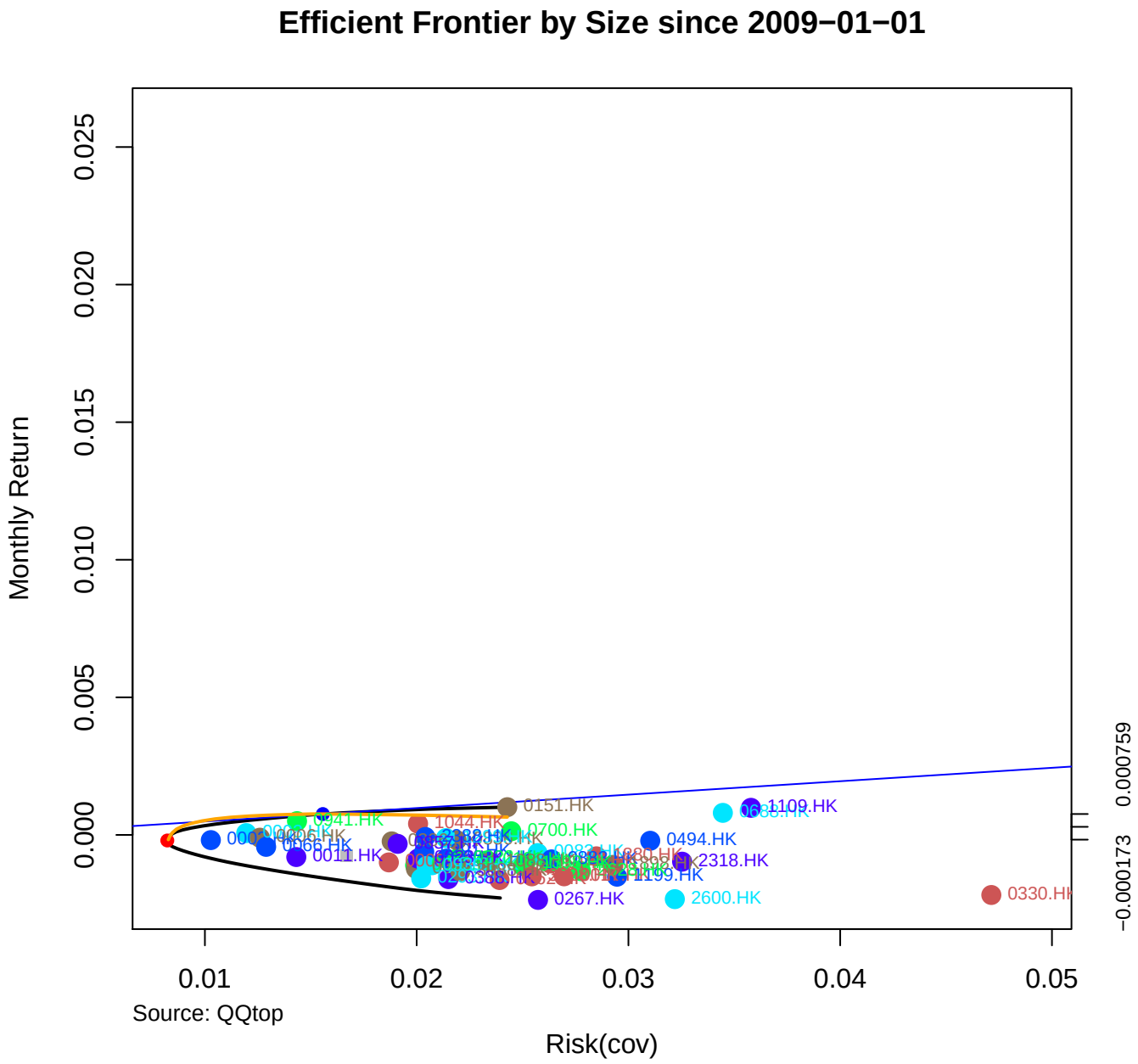
6.1 Performance Chart



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  0.0000  0.0000  0.0000  0.0000  0.1785  0.0000  0.0000  0.0000
```

```
## 25  0.0000  0.2228  0.0618  0.0000  0.0000  0.2434  0.0374  0.0000  0.0000
## 37  0.0000  0.1858  0.2188  0.0000  0.0000  0.2164  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  0.0400  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0595  0.0000  0.0677  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  0.1014
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  1.0000
##    0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK 0388.HK 0494.HK 0688.HK
## 1   0.7142  0.0000  0.0721  0.0000  0.0369  0.0000  0.0000  0.0000  0.0000
## 13  0.2434  0.0000  0.2733  0.0846  0.0285  0.0000  0.0000  0.0000  0.0000
## 25  0.0400  0.0000  0.1437  0.0905  0.0094  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  0.0013  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.1363  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0160  0.0077  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0301  0.0000  0.0000  0.0000  0.1669  0.0597  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 2318.HK 2388.HK 2600.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.1755
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0154
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0209  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
##    2628.HK 3328.HK 3988.HK
## 1   0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000
## 49  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  0.0000  0.0000  0.0000  0.0000  0.0348  0.0000  0.0000  0.0000
## 25  0.0000  0.1754  0.0413  0.0000  0.0000  0.1817  0.0403  0.0000  0.0000
## 37  0.0000  0.1459  0.2041  0.0000  0.0000  0.1809  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  0.0345  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0760  0.0000  0.0611  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  0.1499
## 49  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  1.0000
##    0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK 0388.HK 0494.HK 0688.HK
## 1   0.7481  0.0000  0.0366  0.0000  0.0341  0.0000  0.0000  0.0000  0.0000
## 13  0.3716  0.0000  0.2914  0.0541  0.0404  0.0000  0.0000  0.0000  0.0000
## 25  0.0722  0.0000  0.2068  0.0995  0.0163  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  0.0007  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.1501  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0235  0.0060  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
## 37  0.0000  0.0000  0.0236  0.0000  0.0000  0.0000  0.1976  0.0674  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 2318.HK 2388.HK 2600.HK
## 1   0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.1805
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0232
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0305  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
##    2628.HK 3328.HK 3988.HK
## 1   0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000
## 37  0.0000  0.0000  0.0000
## 49  0.0000  0.0000  0.0000
##
## Target Return and Risks:
##       mean      mu     Cov   Sigma    CVaR     VaR
## 1  -0.0023 -0.0023  0.0239  0.0239  0.0560  0.0405
## 13 -0.0015 -0.0015  0.0147  0.0147  0.0321  0.0257
## 25 -0.0006 -0.0006  0.0092  0.0092  0.0204  0.0161
## 37  0.0002  0.0002  0.0090  0.0090  0.0196  0.0152
## 49  0.0010  0.0010  0.0243  0.0243  0.0488  0.0348
##
## Description:
##  Thu May 31 21:16:00 2012 by user:
```

7 HSI Components Ratios

7.1 Sharpe Ratio - Combined

```
##                                daily.returns
## StdDev Sharpe (Rf=0%, p=95%):       -0.0434
## VaR Sharpe (Rf=0%, p=95%):          -0.0277
## ES Sharpe (Rf=0%, p=95%):           -0.0214
```

7.2 Sharpe - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0194  0.0300  0.0412  0.0413   6e-04
## VaR Sharpe (Rf=0%, p=95%):     0.0129  0.0190  0.0249  0.0283   4e-04
## ES Sharpe (Rf=0%, p=95%):      0.0100  0.0134  0.0108  0.0223   2e-04
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0301  0.0043  0.0254  0.0382  0.0253
## VaR Sharpe (Rf=0%, p=95%):     0.0193  0.0032  0.0177  0.0263  0.0163
## ES Sharpe (Rf=0%, p=95%):      0.0135  0.0031  0.0142  0.0205  0.0110
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0144  0.0343  0.0350  0.0355  0.0241
## VaR Sharpe (Rf=0%, p=95%):     0.0095  0.0215  0.0272  0.0261  0.0159
## ES Sharpe (Rf=0%, p=95%):      0.0066  0.0127  0.0272  0.0224  0.0117
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0265  0.0323  0.0652  0.0196  0.0402
## VaR Sharpe (Rf=0%, p=95%):     0.0183  0.0217  0.0440  0.0144  0.0271
## ES Sharpe (Rf=0%, p=95%):      0.0145  0.0172  0.0334  0.0126  0.0214
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0271  0.0503 -0.0273  0.0306  0.0310
## VaR Sharpe (Rf=0%, p=95%):     0.0177  0.0414 -0.0179  0.0197  0.0222
## ES Sharpe (Rf=0%, p=95%):      0.0132  0.0414 -0.0122  0.0148  0.0183
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## StdDev Sharpe (Rf=0%, p=95%): -0.0068  0.0314  0.0810  0.0180  0.0052
## VaR Sharpe (Rf=0%, p=95%):    -0.0043  0.0228  0.0540  0.0124  0.0033
## ES Sharpe (Rf=0%, p=95%):     -0.0034  0.0193  0.0398  0.0098  0.0026
##                                0857.HK 0883.HK 0939.HK 0941.HK 1044.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0285  0.0423  0.0189  0.0060  0.0697
## VaR Sharpe (Rf=0%, p=95%):     0.0180  0.0278  0.0118  0.0040  0.0483
## ES Sharpe (Rf=0%, p=95%):      0.0136  0.0209  0.0082  0.0031  0.0375
##                                1088.HK 1109.HK 1199.HK 1299.HK 1398.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0363  0.0313  0.0213  0.0207  0.0152
## VaR Sharpe (Rf=0%, p=95%):     0.0231  0.0230  0.0146  0.0131  0.0107
## ES Sharpe (Rf=0%, p=95%):      0.0177  0.0196  0.0116  0.0076  0.0089
##                                1880.HK 1898.HK 2318.HK 2388.HK 2600.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0683  0.0186  0.0300  0.0621  0.0043
## VaR Sharpe (Rf=0%, p=95%):     0.0489  0.0114  0.0200  0.0450  0.0029
## ES Sharpe (Rf=0%, p=95%):      0.0388  0.0077  0.0144  0.0366  0.0023
##                                2628.HK 3328.HK 3988.HK
## StdDev Sharpe (Rf=0%, p=95%): -0.0051  0.0032  0.0277
## VaR Sharpe (Rf=0%, p=95%):    -0.0032  0.0020  0.0183
## ES Sharpe (Rf=0%, p=95%):     -0.0022  0.0015  0.0133
```

7.3 Information Ratio - Combined

```
## [1] "Information Ratio :  -0.0743"
```

7.4 Information Ratio - Distinct

```
##                        0001.HK 0002.HK 0003.HK 0004.HK 0005.HK 0006.HK
## Information Ratio: HSI  -0.072 -0.0746  0.1649  0.2664  -0.307 -0.0198
##                        0011.HK 0012.HK 0013.HK 0016.HK 0017.HK 0019.HK
## Information Ratio: HSI -0.2723  0.0144  0.2002   0.011 -0.1387  0.1355
```

```
##                         0023.HK 0066.HK 0083.HK 0101.HK 0144.HK 0151.HK
## Information Ratio: HSI  0.1505  0.0904 -0.0028  0.0335  0.1197  0.6424
##                         0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK
## Information Ratio: HSI -0.0689  0.2328  0.0395  0.3929 -0.6676   0.083
##                         0388.HK 0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Information Ratio: HSI  0.0941  0.1184  0.1075  0.9965 -0.0834 -0.2506
##                         0857.HK 0883.HK 0939.HK 0941.HK 1044.HK 1088.HK
## Information Ratio: HSI  0.0531  0.2728 -0.0774 -0.2387  0.7473  0.1817
##                         1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK
## Information Ratio: HSI  0.1045 -0.0507   0.543 -0.1266  0.7877   -0.09
##                         2318.HK 2388.HK 2600.HK 2628.HK 3328.HK 3988.HK
## Information Ratio: HSI  0.0852  0.5932 -0.2872  -0.374 -0.2876  0.0461
```

8 HSI Components Table Latest Quotes

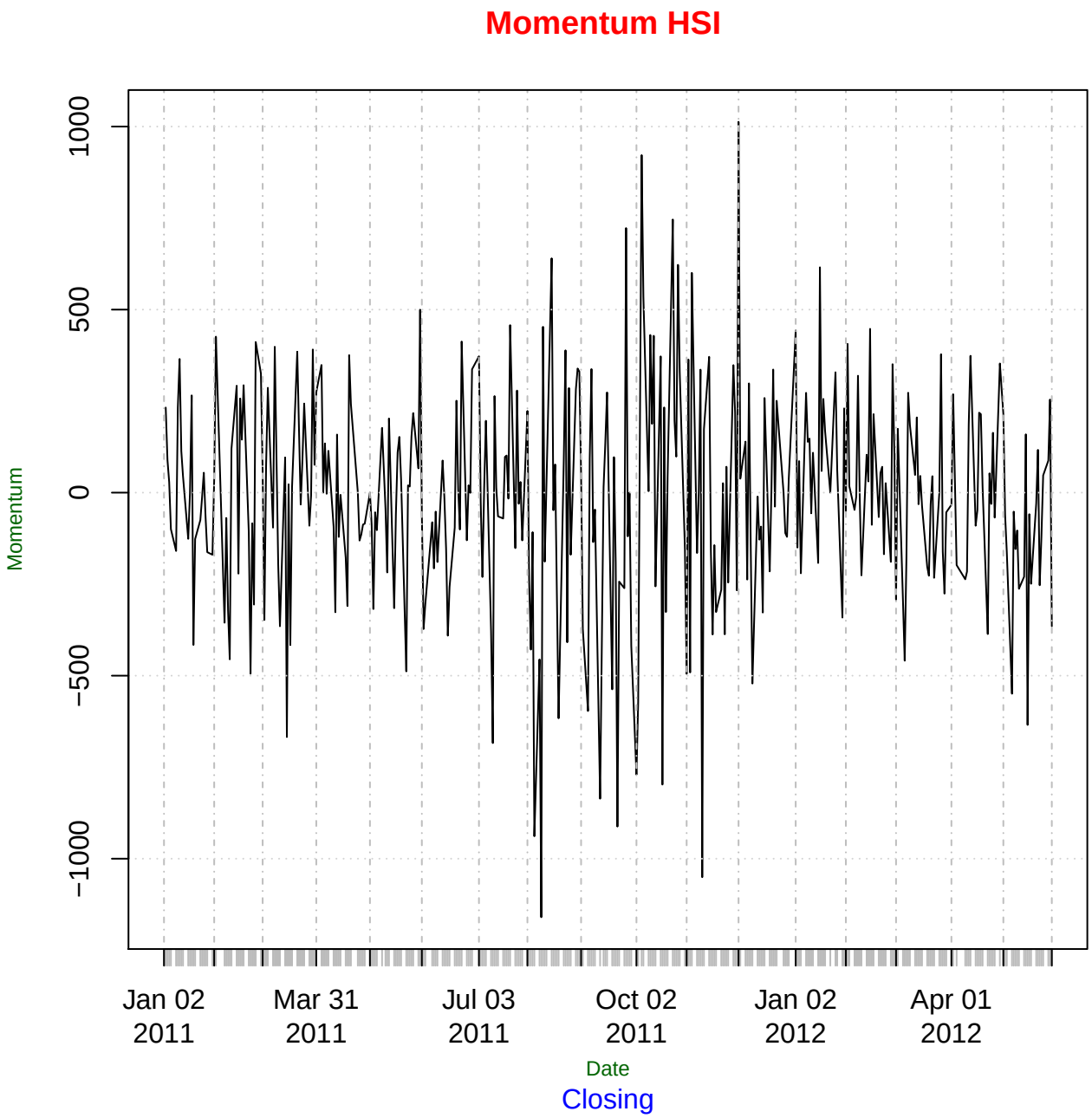
```
## [1] "Date :  2012-05-31 03:59:00"
##                    Name    Bid    Ask Change   52-week Range
## 0001.HK     CHEUNG KONG  89.25  89.60 -0.650  79.10 - 123.00
## 0002.HK    CLP HOLDINGS  63.25  63.35  0.150   62.10 - 75.20
## 0003.HK  HK & CHINA GAS  18.20  18.28  0.000   16.68 - 20.65
## 0004.HK  WHARF HOLDINGS  40.65  40.75 -0.150   33.15 - 59.00
## 0005.HK   HSBC HOLDINGS  61.25  61.30  0.000   56.00 - 82.05
## 0006.HK    POWER ASSETS  54.15  54.40  0.500   52.00 - 64.80
## 0011.HK  HANG SENG BANK 100.30 100.70 -0.100  84.40 - 125.00
## 0012.HK  HENDERSON LAND  38.85  39.20 -0.600   33.20 - 52.65
## 0013.HK       HUTCHISON  63.75  63.85 -1.200   53.60 - 93.10
## 0016.HK         SHK PPT  87.70  88.00  0.350  85.45 - 122.40
## 0017.HK   NEW WORLD DEV   8.33   8.42 -0.080    6.13 - 13.78
## 0019.HK SWIRE PACIFIC A  83.70  83.80 -0.350  75.10 - 120.90
## 0023.HK  BANK OF E ASIA  26.15  26.30 -0.150   21.85 - 34.45
## 0066.HK MTR CORPORATION  25.00  25.10 -0.200   22.45 - 28.55
## 0083.HK       SINO LAND  10.74  10.80  0.040    9.28 - 14.16
## 0101.HK   HANG LUNG PPT  24.75  24.95  0.000   20.85 - 35.30
## 0144.HK  CHINA MER HOLD  23.40  23.55 -0.250   19.00 - 33.40
## 0151.HK WANT WANT CHINA   8.87   8.88 -0.020     6.03 - 9.58
## 0267.HK   CITIC PACIFIC  11.90  12.00  0.220   10.26 - 23.40
## 0291.HK CHINA RESOURCES  24.55  24.60  0.050   24.00 - 35.50
## 0293.HK  CATHAY PAC AIR  11.98  12.04  0.000   11.80 - 20.15
## 0322.HK          TINGYI  18.36  18.48  0.140   17.84 - 26.00
## 0330.HK ESPRIT HOLDINGS  12.38  12.54  0.040    7.55 - 33.30
## 0386.HK    SINOPEC CORP   6.91   6.95 -0.140     6.22 - 9.67
## 0388.HK            HKEX 109.50 110.00 -1.600  99.15 - 172.10
## 0494.HK       LI & FUNG  14.22  14.24 -0.900   10.82 - 20.15
## 0688.HK  CHINA OVERSEAS  16.22  16.26 -0.720    9.99 - 17.86
## 0700.HK         TENCENT 213.40 213.80 -2.000 139.80 - 241.00
## 0762.HK    CHINA UNICOM  10.56  10.70 -0.177   12.60 - 17.64
## 0836.HK CHINA RES POWER  13.96  14.00  0.320   10.82 - 16.20
## 0857.HK      PETROCHINA   9.80   9.82 -0.060    8.59 - 11.92
## 0883.HK           CNOOC  14.00  14.08 -0.160   11.20 - 19.20
## 0939.HK             CCB   5.41   5.42  0.130     4.41 - 7.23
## 0941.HK    CHINA MOBILE  78.20  78.45 -0.650   68.05 - 87.60
## 1044.HK    HENGAN INT'L  74.10  74.50 -0.150   56.80 - 83.45
## 1088.HK   CHINA SHENHUA  27.30  27.45  0.006   27.10 - 40.20
## 1109.HK  CHINA RES LAND  14.64  14.76 -0.380    7.28 - 15.60
## 1199.HK   COSCO PACIFIC   9.54   9.60  0.070    7.52 - 16.50
## 1299.HK             AIA  25.30  25.40  0.150   19.84 - 29.90
## 1398.HK            ICBC   4.71   4.72  0.070     3.46 - 6.47
## 1880.HK     BELLE INT'L  12.40  12.42 -0.260   11.38 - 17.54
## 1898.HK      CHINA COAL   7.15   7.20 -0.020    6.59 - 11.66
## 2318.HK         PING AN  57.10  57.15 -0.550   37.35 - 83.75
## 2388.HK   BOC HONG KONG  21.35  21.50 -0.642   14.24 - 24.65
## 2600.HK          CHALCO   3.36   3.37 -0.020     3.20 - 6.88
## 2628.HK      CHINA LIFE  18.30  18.32 -0.040   17.04 - 28.10
## 3328.HK        BANKCOMM   5.04   5.06 -0.030     4.15 - 7.99
## 3988.HK   BANK OF CHINA   2.97   2.98  0.050     2.20 - 4.11
```

9 Hang Seng Index

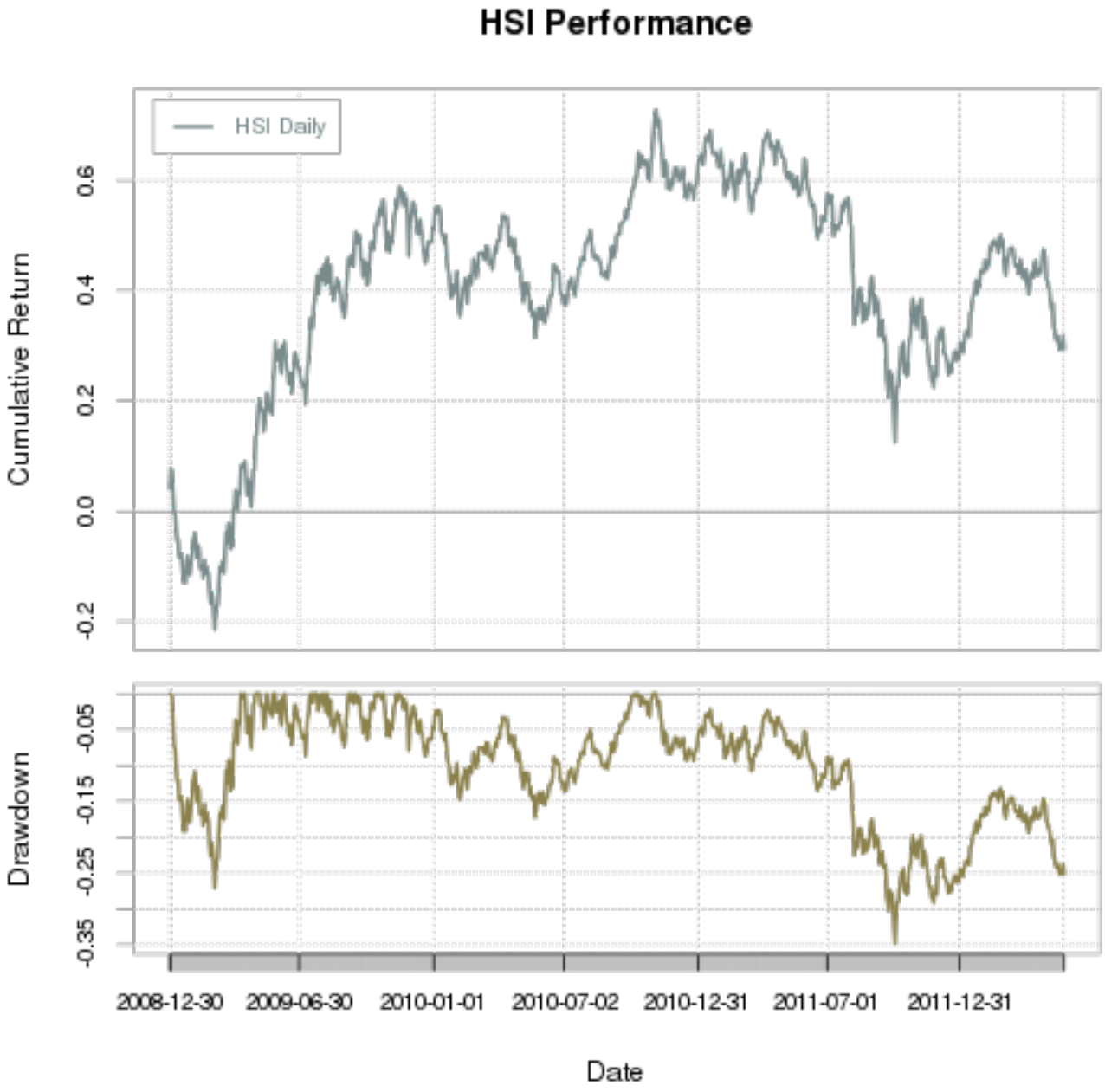
Latest Hang Seng Index

	Trade Time	Name	Last	Change	Days Range	52−week Range
^HSI	2012−05−31 04:01:00	HANG SENG INDEX	18630	−60.7	18378.141 − 18657.90	16170.30 − 23706.00

9.1 Hang Seng Index - Momentum

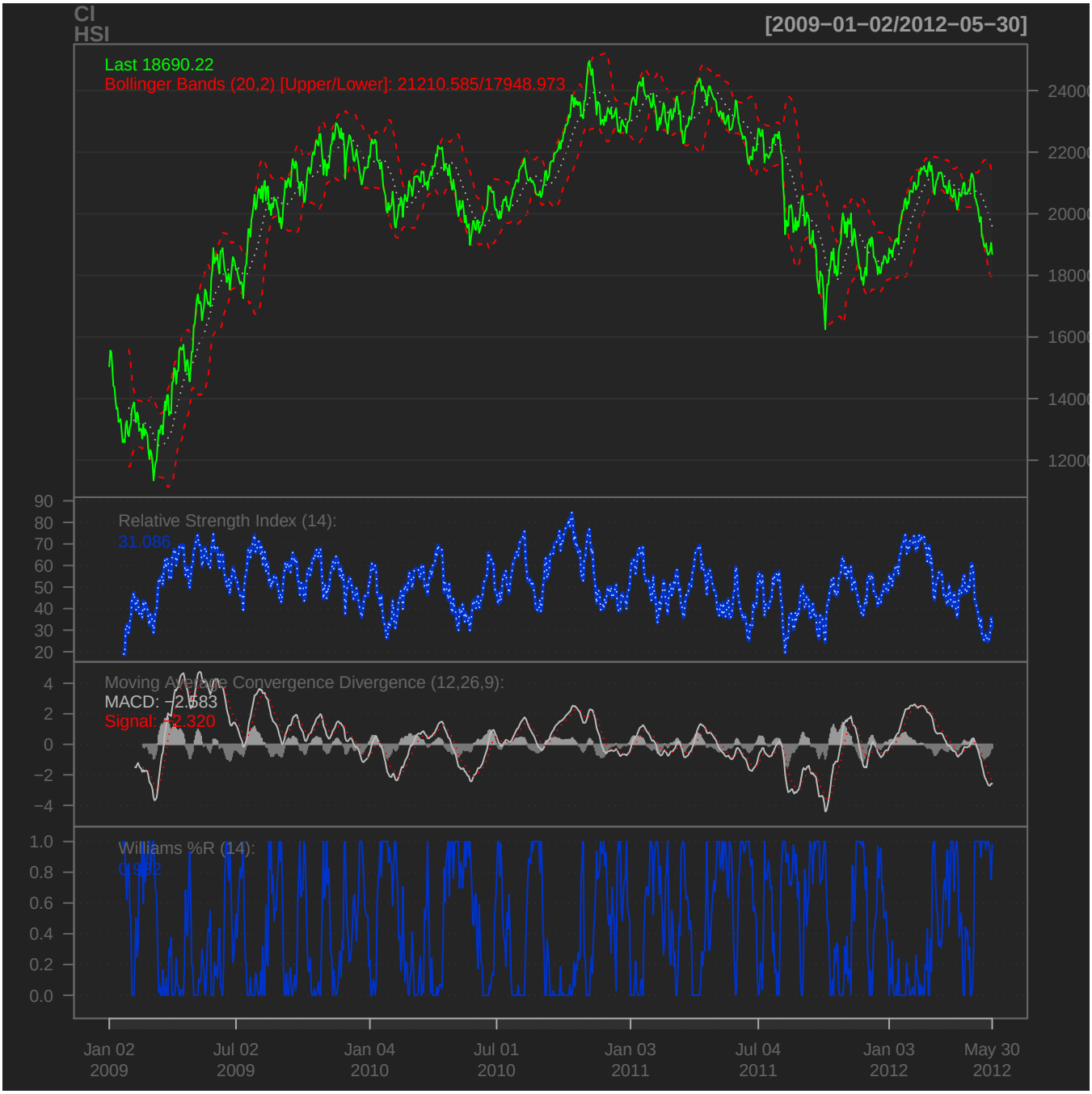


9.2 HSI Performance

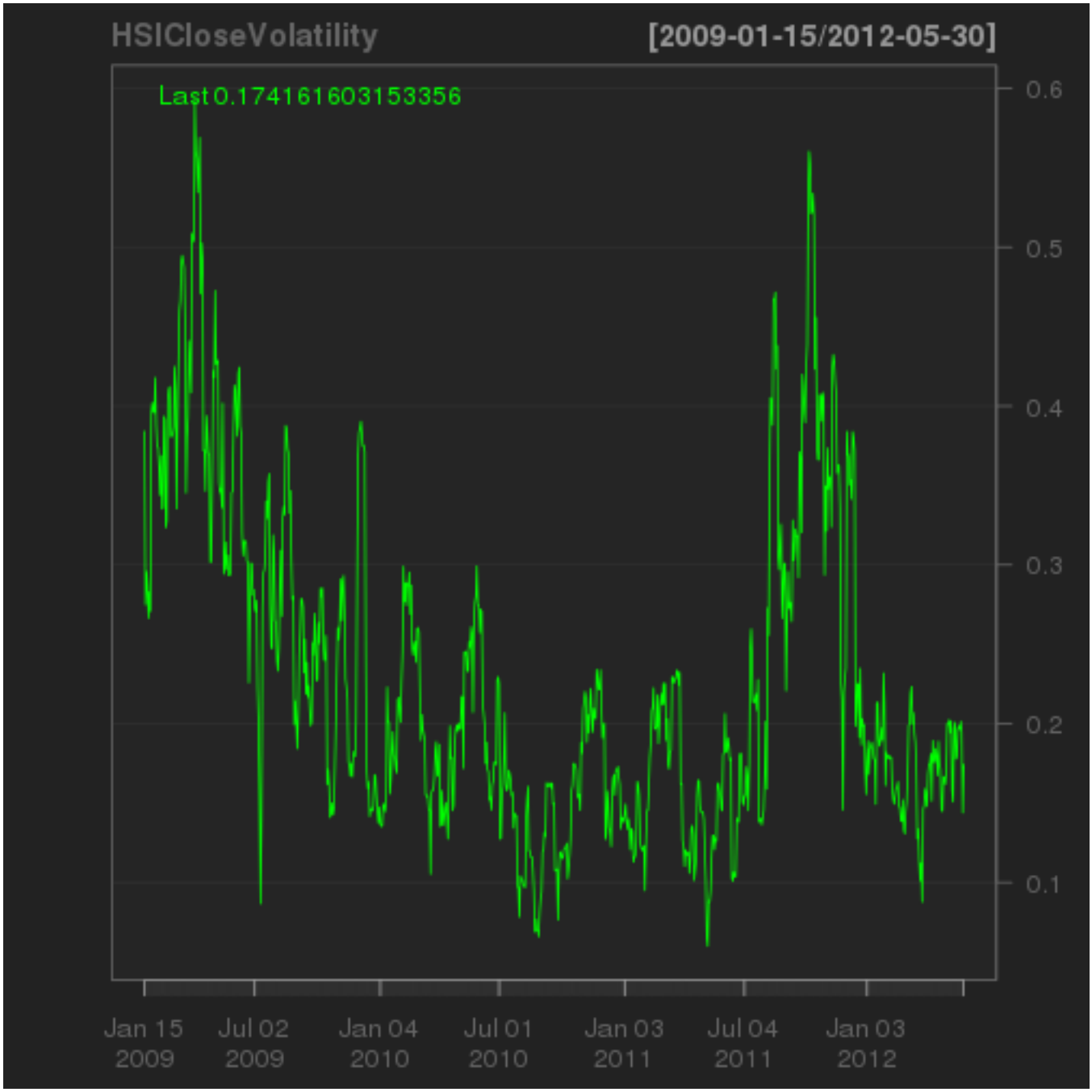


9.3 HSI Ratios

```
##              RSI
## 2012-05-16 27.76
## 2012-05-17 25.38
## 2012-05-20 25.10
## 2012-05-21 28.41
## 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
##              macd  signal
## 2012-05-16 -1.647 -0.8215
## 2012-05-17 -1.958 -1.0488
## 2012-05-20 -2.195 -1.2780
## 2012-05-21 -2.311 -1.4845
## 2012-05-22 -2.481 -1.6837
## 2012-05-23 -2.637 -1.8745
## 2012-05-24 -2.714 -2.0423
## 2012-05-27 -2.708 -2.1755
## 2012-05-28 -2.569 -2.2542
## 2012-05-29 -2.583 -2.3198
## [1] "BBands"
##                dn  mavg    up    pctB
## 2012-05-16 19293 20494 21695 -0.0384
## 2012-05-17 19041 20392 21743 -0.0329
## 2012-05-20 18825 20287 21749  0.0331
## 2012-05-21 18659 20208 21757  0.1228
## 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
##              WPR %
## 2012-05-16 100.00
## 2012-05-17 100.00
## 2012-05-20 100.00
## 2012-05-21  94.98
## 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
```


CI
HSI
[2009−01−02/2012−05−30]
Last 18690.22
Bollinger Bands (20,2) [Upper/Lower]: 21210.585/17948.973
Relative Strength Index (14):
31.086
Moving Average Convergence Divergence (12,26,9):
MACD: −2.583
Signal: −2.320
Williams %R (14):
Jan 02 2009
Jul 02 2009
Jan 04 2010
Jul 01 2010
Jan 03 2011
Jul 04 2011
Jan 03 2012
May 30 2012

9.4 HSI Volatility



9.5 HSI Statistics

```
##                                HSI-Daily HSI-Monthly
## StdDev Sharpe (Rf=0%, p=95%):   0.02685     0.10935
## VaR Sharpe (Rf=0%, p=95%):      0.01732     0.07338
## ES Sharpe (Rf=0%, p=95%):       0.01277     0.05858
##          HSI-Daily HSI-Monthly
## Skewness    0.1264      0.0895
##          HSI-Daily HSI-Monthly
## Kurtosis     1.505     -0.2015
```

```
##      Index              HSI Daily
##  Min.   :2008-12-31   Min.   :-5.66e-02
##  1st Qu.:2009-11-04   1st Qu.:-8.12e-03
##  Median :2010-09-11   Median : 6.01e-05
##  Mean   :2010-09-12   Mean   : 4.25e-04
##  3rd Qu.:2011-07-18   3rd Qu.: 9.94e-03
##  Max.   :2012-05-28   Max.   : 7.41e-02
##      Index             HSI Monthly
##  Min.   :2009-01-28   Min.   :-0.14329
##  1st Qu.:2009-11-28   1st Qu.:-0.03514
##  Median :2010-09-28   Median : 0.00812
##  Mean   :2010-09-27   Mean   : 0.00773
##  3rd Qu.:2011-07-27   3rd Qu.: 0.03806
##  Max.   :2012-05-28   Max.   : 0.17074
```

10 Dataset First and Last Rows Info

```
##            X0001.HK.Close
## 2009-01-02          76.90
## 2012-05-30          90.15
##            X0002.HK.Close
## 2009-01-02          52.40
## 2012-05-30          63.05
##            X0003.HK.Close
## 2009-01-02          12.08
## 2012-05-30          18.22
##            X0004.HK.Close
## 2009-01-02          22.00
## 2012-05-30          40.65
##            X0005.HK.Close
## 2009-01-02           77.0
## 2012-05-30           61.2
##            X0006.HK.Close
## 2009-01-02          42.75
## 2012-05-30          53.75
##            X0011.HK.Close
## 2009-01-02          104.7
## 2012-05-30          100.4
##            X0012.HK.Close
## 2009-01-02          30.35
## 2012-05-30          39.70
##            X0013.HK.Close
## 2009-01-02          39.85
## 2012-05-30          65.05
##            X0016.HK.Close
## 2009-01-02           67.3
## 2012-05-30           87.4
##            X0017.HK.Close
## 2009-01-02           8.18
## 2012-05-30           8.44
##            X0019.HK.Close
## 2009-01-02          55.75
## 2012-05-30          84.10
##            X0023.HK.Close
## 2009-01-02          16.68
## 2012-05-30          26.10
##            X0066.HK.Close
## 2009-01-02          18.08
## 2012-05-30          25.30
##            X0083.HK.Close
## 2009-01-02           8.36
## 2012-05-30          10.66
##            X0101.HK.Close
## 2009-01-02          18.36
## 2012-05-30          24.75
##            X0144.HK.Close
## 2009-01-02           15.4
## 2012-05-30           23.8
##            X0151.HK.Close
## 2009-01-02           3.17
## 2012-05-30           8.91
##            X0267.HK.Close
```

```
## 2009-01-02          10.20
## 2012-05-30          11.76
##            X0291.HK.Close
## 2009-01-02          14.00
## 2012-05-30          24.55
##            X0293.HK.Close
## 2009-01-02           8.91
## 2012-05-30          12.02
##            X0322.HK.Close
## 2009-01-02           8.98
## 2012-05-30          18.30
##            X0330.HK.Close
## 2009-01-02          44.80
## 2012-05-30          12.44
##            X0386.HK.Close
## 2009-01-02           4.96
## 2012-05-30           7.05
##            X0388.HK.Close
## 2009-01-02           76.6
## 2012-05-30          111.2
##            X0494.HK.Close
## 2011-06-02          17.92
## 2012-05-30          15.14
##            X0688.HK.Close
## 2009-01-02          11.22
## 2012-05-30          16.96
##            X0700.HK.Close
## 2009-01-01           50.0
## 2012-05-30          215.4
##            X0762.HK.Close
## 2009-01-01           9.63
## 2012-05-30          10.98
##            X0836.HK.Close
## 2009-01-02          15.12
## 2012-05-30          13.72
##            X0857.HK.Close
## 2009-01-02           7.20
## 2012-05-30           9.88
##            X0883.HK.Close
## 2009-01-02           7.59
## 2012-05-30          14.18
##            X0939.HK.Close
## 2009-01-02           4.52
## 2012-05-30           5.25
##            X0941.HK.Close
## 2009-01-02          81.20
## 2012-05-30          79.15
##            X1044.HK.Close
## 2009-01-01           24.9
## 2012-05-30           74.4
##            X1088.HK.Close
## 2009-01-02          17.40
## 2012-05-30          28.45
##            X1109.HK.Close
## 2009-01-02           9.90
## 2012-05-30          15.04
##            X1199.HK.Close
```

```
## 2009-01-02           8.07
## 2012-05-30           9.46
##            X1299.HK.Close
## 2010-10-29           23.1
## 2012-05-30           25.1
##            X1398.HK.Close
## 2009-01-02           4.30
## 2012-05-30           4.66
##            X1880.HK.Close
## 2009-01-02           3.50
## 2012-05-30          12.72
##            X1898.HK.Close
## 2009-01-02           6.55
## 2012-05-30           7.22
##            X2318.HK.Close
## 2009-01-02           39.6
## 2012-05-30           57.7
##            X2388.HK.Close
## 2009-01-02           9.06
## 2012-05-30          22.55
##            X2600.HK.Close
## 2009-01-02           4.55
## 2012-05-30           3.38
##            X2628.HK.Close
## 2009-01-02          24.75
## 2012-05-30          18.26
##            X3328.HK.Close
## 2009-01-02           5.91
## 2012-05-30           5.07
##            X3988.HK.Close
## 2009-01-02           2.17
## 2012-05-30           2.94
```

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

Currently this paper is automatically generated with a daily cron job.
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