# 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                               -0.0002
## Beta                                 0.0882
## Beta+                               -0.3502
## Beta-                                0.3317
## R-squared                            0.0029
## Annualized Alpha                    -0.0440
## Correlation                          0.0536
## Correlation p-value                  0.3620
## Tracking Error                       0.4228
## Active Premium                      -0.0235
## Information Ratio                   -0.0555
## Treynor Ratio                       -1.2713
```

[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                           1.079           0.265           0.337
## Beta+                          1.064           0.121           0.020
## Beta-                          0.971           0.307           0.502
## R-squared                      0.682           0.171           0.204
## Annualized Alpha              -0.002           0.024           0.101
## Correlation                    0.826           0.414           0.452
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.172           0.218           0.219
## Active Premium                -0.026           0.131           0.189
## Information Ratio             -0.153           0.599           0.865
## Treynor Ratio                 -0.168          -0.092           0.102
##                      X0004.HK to HSI X0005.HK to HSI X0006.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           1.206           0.984           0.180
## Beta+                          1.259           0.954           0.017
## Beta-                          1.138           1.096           0.233
## R-squared                      0.579           0.726           0.052
## Annualized Alpha               0.024           0.000           0.102
## Correlation                    0.761           0.852           0.228
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.244           0.141           0.261
## Active Premium                -0.038          -0.006           0.212
## Information Ratio             -0.154          -0.041           0.809
## Treynor Ratio                 -0.160          -0.163           0.313
##                      X0011.HK to HSI X0012.HK to HSI X0013.HK to HSI
## Alpha                          0.000           0.000           0.000
## Beta                           0.651           1.001           1.069
## Beta+                          0.643           0.922           1.036
## Beta-                          0.701           0.984           1.093
## R-squared                      0.497           0.571           0.616
## Annualized Alpha               0.015          -0.071           0.086
## Correlation                    0.705           0.756           0.785
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.173           0.202           0.197
## Active Premium                 0.059          -0.076           0.043
## Information Ratio              0.344          -0.376           0.218
## Treynor Ratio                 -0.147          -0.231          -0.105
##                      X0016.HK to HSI X0017.HK to HSI X0019.HK to HSI
## Alpha                          0.000          -0.001           0.000
## Beta                           0.934           1.097           0.758
## Beta+                          0.996           0.758           0.765
## Beta-                          0.759           1.184           0.660
## R-squared                      0.569           0.462           0.343
## Annualized Alpha              -0.099          -0.195          -0.064
## Correlation                    0.754           0.680           0.585
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.190           0.277           0.251
## Active Premium                -0.088          -0.204          -0.042
## Information Ratio             -0.462          -0.736          -0.168
## Treynor Ratio                 -0.260          -0.327          -0.260
##                      X0023.HK to HSI X0066.HK to HSI X0083.HK to HSI
## Alpha                          0.000           0.000           0.000
```

```
## Beta                          0.888           0.548           1.173
## Beta+                         1.009           0.533           1.292
## Beta-                         0.864           0.568           1.196
## R-squared                     0.517           0.436           0.533
## Annualized Alpha             -0.022          -0.036          -0.050
## Correlation                   0.719           0.660           0.730
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.201           0.179           0.259
## Active Premium               -0.017           0.031          -0.095
## Information Ratio            -0.084           0.173          -0.366
## Treynor Ratio                -0.194          -0.226          -0.213
##                      X0101.HK to HSI X0144.HK to HSI X0151.HK to HSI
## Alpha                         0.000           0.001           0.001
## Beta                          1.064           1.270           0.640
## Beta+                         1.014           1.220           0.501
## Beta-                         1.106           1.236           0.775
## R-squared                     0.519           0.518           0.163
## Annualized Alpha             -0.082           0.196           0.410
## Correlation                   0.721           0.719           0.404
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.239           0.292           0.347
## Active Premium               -0.100           0.073           0.359
## Information Ratio            -0.421           0.251           1.034
## Treynor Ratio                -0.240          -0.064           0.319
##                      X0267.HK to HSI X0291.HK to HSI X0293.HK to HSI
## Alpha                        -0.001           0.000          -0.001
## Beta                          1.171           0.815           0.784
## Beta+                         1.317           0.659           0.815
## Beta-                         1.101           0.950           0.576
## R-squared                     0.538           0.364           0.335
## Annualized Alpha             -0.173          -0.005          -0.178
## Correlation                   0.733           0.603           0.579
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.256           0.255           0.262
## Active Premium               -0.191          -0.002          -0.145
## Information Ratio            -0.748          -0.006          -0.555
## Treynor Ratio                -0.296          -0.192          -0.383
##                      X0322.HK to HSI X0330.HK to HSI X0386.HK to HSI
## Alpha                         0.000          -0.002           0.000
## Beta                          0.445           1.049           0.883
## Beta+                         0.613           1.069           0.740
## Beta-                         0.564           1.247           0.706
## R-squared                     0.099           0.154           0.484
## Annualized Alpha              0.106          -0.346           0.122
## Correlation                   0.314           0.392           0.695
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.339           0.573           0.214
## Active Premium                0.139          -0.381           0.103
## Information Ratio             0.409          -0.666           0.482
## Treynor Ratio                -0.037          -0.511          -0.058
##                      X0388.HK to HSI X0494.HK to HSI X0688.HK to HSI
## Alpha                         0.000          -0.001           0.001
## Beta                          1.102           1.258           1.456
## Beta+                         1.216           1.183           2.014
## Beta-                         1.037           1.222           1.270
## R-squared                     0.682           0.226           0.519
## Annualized Alpha             -0.092          -0.224           0.312
```

```
## Correlation                   0.826           0.475           0.720
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.177           0.546           0.343
## Active Premium               -0.104          -0.335           0.113
## Information Ratio            -0.590          -0.614           0.329
## Treynor Ratio                -0.235          -0.390          -0.029
##                      X0700.HK to HSI X0762.HK to HSI X0836.HK to HSI
## Alpha                          0.001           0.000           0.000
## Beta                           1.113           0.971           0.492
## Beta+                          1.235           0.903           0.309
## Beta-                          1.036           1.070           0.575
## R-squared                      0.440           0.392           0.122
## Annualized Alpha               0.426           0.132           0.072
## Correlation                    0.663           0.626           0.349
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.294           0.281           0.329
## Active Premium                 0.284           0.080           0.102
## Information Ratio              0.968           0.284           0.311
## Treynor Ratio                  0.116          -0.077          -0.107
##                      X0857.HK to HSI X0883.HK to HSI X0939.HK to HSI
## Alpha                          0.001           0.001           0.000
## Beta                           0.995           1.375           1.097
## Beta+                          0.891           1.566           1.123
## Beta-                          0.983           1.391           1.009
## R-squared                      0.613           0.698           0.758
## Annualized Alpha               0.202           0.161          -0.055
## Correlation                    0.783           0.836           0.870
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.184           0.228           0.146
## Active Premium                 0.155           0.044          -0.070
## Information Ratio              0.843           0.191          -0.476
## Treynor Ratio                  0.000          -0.081          -0.205
##                      X0941.HK to HSI X1044.HK to HSI X1088.HK to HSI
## Alpha                          0.000           0.001           0.000
## Beta                           0.542           0.631           1.183
## Beta+                          0.380           0.715           1.133
## Beta-                          0.557           0.727           1.223
## R-squared                      0.383           0.220           0.652
## Annualized Alpha               0.084           0.170           0.000
## Correlation                    0.619           0.469           0.808
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.192           0.290           0.205
## Active Premium                 0.138           0.175          -0.047
## Information Ratio              0.718           0.603          -0.228
## Treynor Ratio                 -0.031           0.031          -0.171
##                      X1109.HK to HSI X1199.HK to HSI X1299.HK to HSI
## Alpha                          0.001           0.001           0.001
## Beta                           1.488           1.410           0.813
## Beta+                          2.005           1.438           0.801
## Beta-                          1.203           1.600           1.059
## R-squared                      0.491           0.564           0.384
## Annualized Alpha               0.290           0.149           0.196
## Correlation                    0.700           0.751           0.619
## Correlation p-value            0.000           0.000           0.000
## Tracking Error                 0.371           0.304           0.244
## Active Premium                 0.081           0.011           0.173
## Information Ratio              0.219           0.035           0.708
```

```
## Treynor Ratio                -0.050          -0.102           0.022
##                      X1398.HK to HSI X1880.HK to HSI X1898.HK to HSI
## Alpha                         0.000           0.000          -0.001
## Beta                          1.322           1.039           1.376
## Beta+                         1.511           1.241           1.489
## Beta-                         1.204           0.907           1.294
## R-squared                     0.784           0.363           0.602
## Annualized Alpha              0.034           0.114          -0.178
## Correlation                   0.886           0.602           0.776
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.178           0.321           0.275
## Active Premium               -0.037           0.043          -0.224
## Information Ratio            -0.208           0.133          -0.816
## Treynor Ratio                -0.145          -0.108          -0.276
##                      X2318.HK to HSI X2388.HK to HSI X2600.HK to HSI
## Alpha                         0.000           0.000          -0.001
## Beta                          1.580           0.985           1.427
## Beta+                         1.893           0.965           1.584
## Beta-                         1.375           0.996           1.326
## R-squared                     0.664           0.570           0.566
## Annualized Alpha              0.039           0.114          -0.222
## Correlation                   0.815           0.755           0.752
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.294           0.199           0.308
## Active Premium               -0.094           0.081          -0.268
## Information Ratio            -0.320           0.406          -0.872
## Treynor Ratio                -0.158          -0.075          -0.296
##                      X2628.HK to HSI X3328.HK to HSI X3988.HK to HSI
## Alpha                        -0.001          -0.001           0.000
## Beta                          1.284           1.266           1.140
## Beta+                         1.384           1.296           1.105
## Beta-                         1.208           1.257           1.103
## R-squared                     0.638           0.719           0.742
## Annualized Alpha             -0.184          -0.154          -0.122
## Correlation                   0.799           0.848           0.861
## Correlation p-value           0.000           0.000           0.000
## Tracking Error                0.235           0.194           0.160
## Active Premium               -0.211          -0.179          -0.132
## Information Ratio            -0.899          -0.921          -0.826
## Treynor Ratio                -0.285          -0.264          -0.252
```

# 3 HSI Components Risk

## 3.1 Correlation

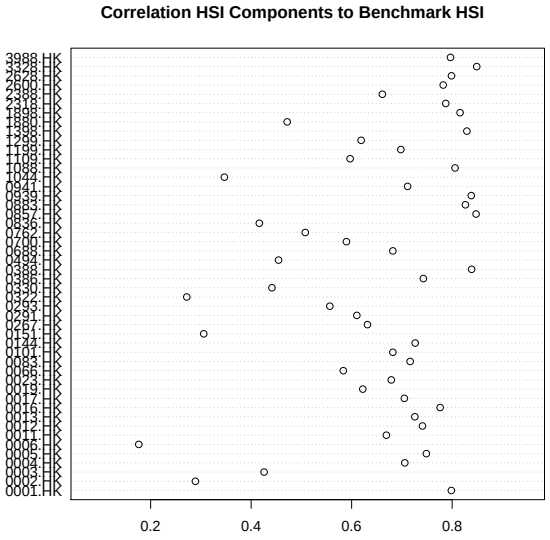
*Correlation Combined*

```
##                       Correlation p-value Lower CI Upper CI
## HSI Components to HSI      0.0536   0.362  -0.0978   0.2026
```

*Correlation - Distinct*

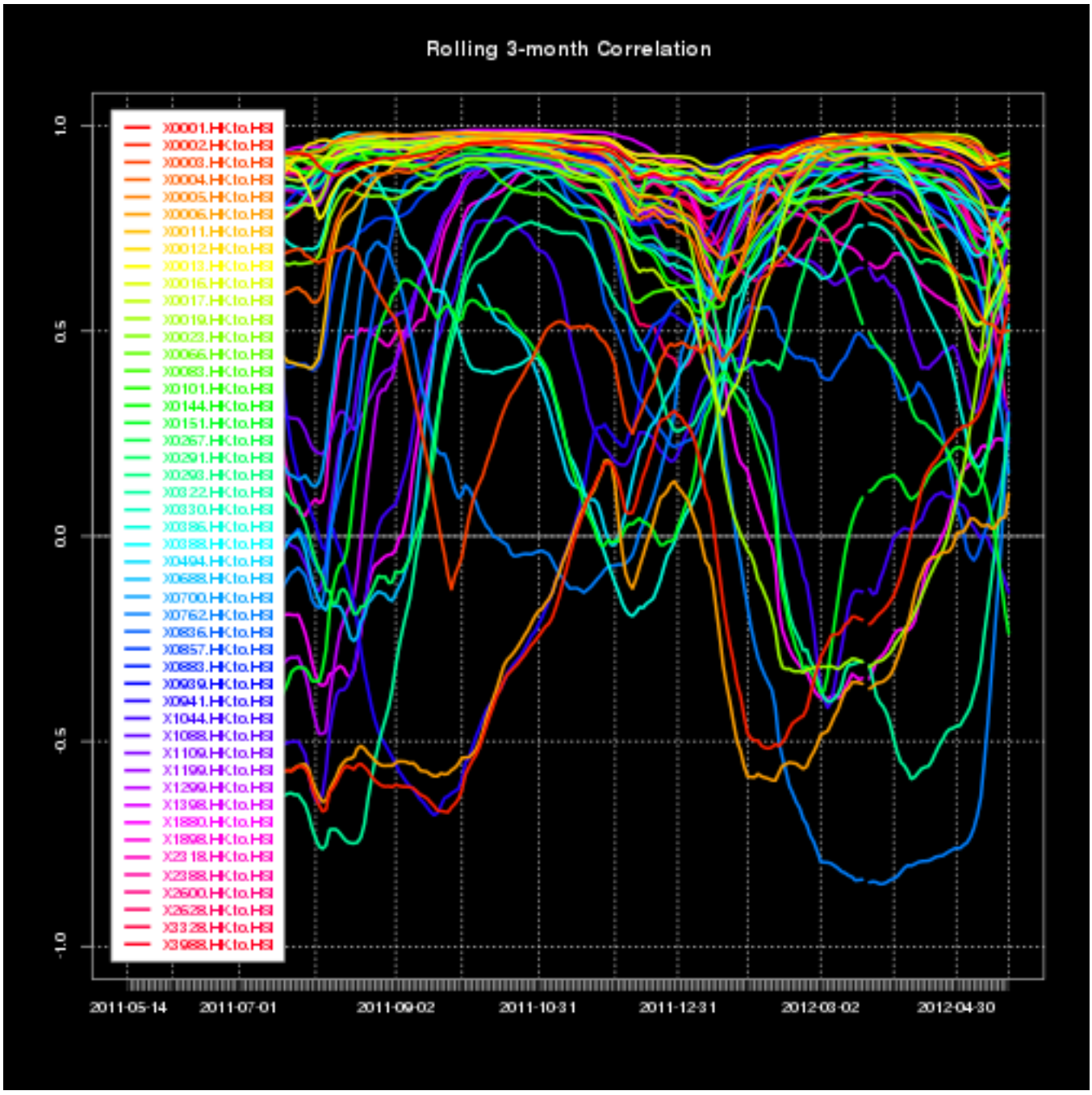
```
##         Correlation p-value Lower CI Upper CI
## 0001.HK      0.7984       0   0.7637   0.8284
## 0002.HK      0.2891       0   0.2056   0.3685
## 0003.HK      0.4258       0   0.3503   0.4958
## 0004.HK      0.7058       0   0.6582   0.7477
## 0005.HK      0.7487       0   0.7069   0.7853
## 0006.HK      0.1764       0   0.0891   0.2611
## 0011.HK      0.6691       0   0.6169   0.7153
## 0012.HK      0.7410       0   0.6981   0.7785
## 0013.HK      0.7258       0   0.6809   0.7653
## 0016.HK      0.7761       0   0.7381   0.8091
## 0017.HK      0.7049       0   0.6573   0.7469
## 0019.HK      0.6222       0   0.5646   0.6737
## 0023.HK      0.6789       0   0.6279   0.7240
## 0066.HK      0.5834       0   0.5216   0.6390
## 0083.HK      0.7164       0   0.6702   0.7570
## 0101.HK      0.6820       0   0.6315   0.7268
## 0144.HK      0.7265       0   0.6817   0.7659
## 0151.HK      0.3057       0   0.2230   0.3841
## 0267.HK      0.6315       0   0.5749   0.6820
## 0291.HK      0.6103       0   0.5514   0.6631
## 0293.HK      0.5566       0   0.4921   0.6150
## 0322.HK      0.2719       0   0.1877   0.3521
## 0330.HK      0.4414       0   0.3669   0.5102
## 0386.HK      0.7427       0   0.7000   0.7800
## 0388.HK      0.8388       0   0.8104   0.8633
## 0494.HK      0.4546       0   0.3807   0.5227
## 0688.HK      0.6820       0   0.6314   0.7268
## 0700.HK      0.5896       0   0.5286   0.6446
## 0762.HK      0.5077       0   0.4388   0.5707
## 0836.HK      0.4163       0   0.3401   0.4871
## 0857.HK      0.8476       0   0.8205   0.8708
## 0883.HK      0.8264       0   0.7960   0.8527
## 0939.HK      0.8381       0   0.8095   0.8627
## 0941.HK      0.7114       0   0.6646   0.7526
## 1044.HK      0.3467       0   0.2662   0.4223
## 1088.HK      0.8058       0   0.7723   0.8349
## 1109.HK      0.5970       0   0.5366   0.6512
## 1199.HK      0.6979       0   0.6494   0.7408
## 1299.HK      0.6189       0   0.5313   0.6934
## 1398.HK      0.8293       0   0.7994   0.8552
## 1880.HK      0.4717       0   0.3996   0.5380
## 1898.HK      0.8158       0   0.7837   0.8435
## 2318.HK      0.7873       0   0.7511   0.8189
## 2388.HK      0.6611       0   0.6080   0.7083
## 2600.HK      0.7822       0   0.7452   0.8144
## 2628.HK      0.7987       0   0.7641   0.8287
```

```
## 3328.HK      0.8489       0   0.8221   0.8719
## 3988.HK      0.7967       0   0.7617   0.8270
```



*3 Month Rolling Correlation*

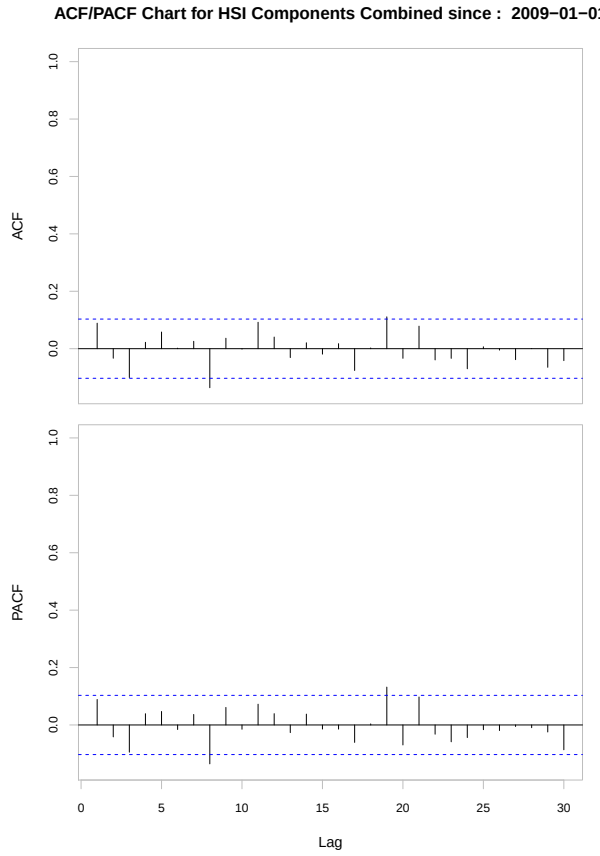
```
## Error: improper length of one or more arguments to merge.xts
```



## 3.2 Autocorrelation Coefficients - Combined

*Autocorrelation Combined*

```
##                  rho1    rho2    rho3   rho4   rho5   rho6 Q(6) p-value
## daily.returns 0.0888 -0.0333 -0.1007 0.0222 0.0581 0.0019       0.1877
```



### 3.3 Downside Risk - Combined

*Downside Risk Combined*

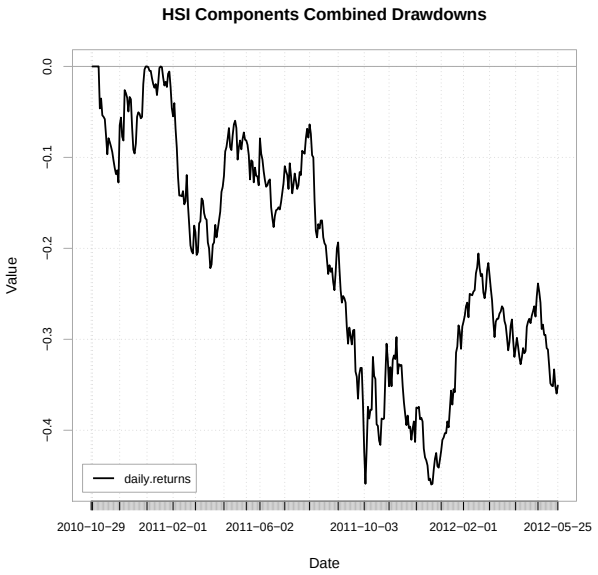
```
##                                HSI Components dailyReturn
## Semi Deviation                                      0.0219
## Gain Deviation                                      0.0171
## Loss Deviation                                      0.0144
## Downside Deviation (MAR=210%)                       0.0254
## Downside Deviation (Rf=0%)                          0.0222
## Downside Deviation (0%)                             0.0222
## Maximum Drawdown                                    0.4597
## Historical VaR (95%)                               -0.0350
## Historical ES (95%)                                -0.0488
## Modified VaR (95%)                                 -0.0357
## Modified ES (95%)                                  -0.0456
```

## 3.4 Drawdowns - Combined

*Drawdowns Combined*

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

```
##         From     Trough         To   Depth Length To Trough Recovery
## 1 2011-01-19 2011-12-19       <NA> -0.4597    321       218       NA
## 2 2010-11-09 2010-11-30 2010-12-31 -0.1276     38        16       22
## 3 2011-01-04 2011-01-13 2011-01-18 -0.0315     11         8        3
```



## 3.5 Downside Deviation - Combined

*Downside Deviation Combined*

```
##                                 HSI Components
## Downside Deviation (MAR = 0%)          0.02218
```

## 3.6 Downside Deviation - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## Downside Deviation (MAR = 0%)   0.019  0.0088  0.0152  0.0238  0.0247
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## Downside Deviation (MAR = 0%)   0.011  0.0147  0.0211  0.0188  0.0202
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## Downside Deviation (MAR = 0%)  0.0244  0.0206  0.0203   0.013  0.0252
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## Downside Deviation (MAR = 0%)  0.0248  0.0266  0.0218  0.0246  0.0227
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## Downside Deviation (MAR = 0%)  0.0213    0.02  0.0351  0.0203  0.0194
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Downside Deviation (MAR = 0%)  0.0375  0.0257  0.0243  0.0228  0.0203
##                                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  0.0196   0.021
##                                1880.HK 1898.HK 2318.HK 2388.HK 2600.HK
## Downside Deviation (MAR = 0%)  0.0268  0.0289  0.0263  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          841  12   56.00     91.700  98.500          100.241
## X0002.HK.Close          840  13   51.10     52.700  59.950           59.769
## X0003.HK.Close          841  12   10.78     17.280  18.260           17.755
## X0004.HK.Close          840  13   15.20     37.587  42.150           41.985
## X0005.HK.Close          841  12   33.00     66.400  77.050           74.403
## X0006.HK.Close          841  12   41.10     43.700  47.800           49.665
## X0011.HK.Close          841  12   67.00    102.500 109.500          109.025
## X0012.HK.Close          841  12   23.75     42.800  48.000           46.728
## X0013.HK.Close          840  13   36.40     53.388  61.125           64.889
## X0016.HK.Close          841  12   55.80     98.550 111.000          107.749
## X0017.HK.Close          841  12    6.20      9.350  13.260           12.457
## X0019.HK.Close          840  13   42.90     84.938  91.500           92.169
## X0023.HK.Close          840  13   12.34     26.950  29.000           28.276
## X0066.HK.Close          841  12   16.14     25.250  26.900           26.109
## X0083.HK.Close          840  13    5.60     11.920  13.500           13.064
## X0101.HK.Close          841  12   13.66     25.750  28.800           28.556
## X0144.HK.Close          840  13   12.20     23.238  26.250           25.921
## X0151.HK.Close          840  13    2.77      4.925   6.300            6.049
## X0267.HK.Close          840  13    7.18     13.820  16.800           16.767
## X0291.HK.Close          841  12   10.66     24.850  27.950           26.229
## X0293.HK.Close          841  12    6.98     12.720  14.680           15.080
## X0322.HK.Close          841  12    8.27     17.300  19.460           18.459
## X0330.HK.Close          840  13    7.93     22.938  41.500           37.358
## X0386.HK.Close          840  13    3.65      6.228   6.875            6.937
## X0388.HK.Close          841  12   54.60    123.100 135.000          136.029
## X0494.HK.Close          830  23   11.60     16.670  28.375           28.157
## X0688.HK.Close          840  13    9.41     14.380  15.530           15.246
## X0700.HK.Close          849   4   41.80    130.300 158.300          153.158
## X0762.HK.Close          847   6    8.31      9.820  11.160           12.001
## X0836.HK.Close          840  13   11.10     14.160  15.220           15.353
## X0857.HK.Close          840  13    5.10      8.750   9.480            9.448
## X0883.HK.Close          840  13    6.08     11.765  13.520           13.768
## X0939.HK.Close          840  13    3.66      5.647   6.230            6.108
## X0941.HK.Close          841  12   63.00     73.650  76.300           76.297
## X1044.HK.Close          852   1   24.25     50.175  60.825           57.683
## X1088.HK.Close          840  13   13.90     30.387  33.325           31.769
## X1109.HK.Close          840  13    7.50     13.040  14.480           14.370
## X1199.HK.Close          840  13    5.40      9.488  11.080           11.122
## X1299.HK.Close          388 465   19.86     23.000  24.600           24.926
## X1398.HK.Close          841  12    3.03      4.980   5.680            5.438
## X1880.HK.Close          840  13    2.98      8.385  12.610           11.253
## X1898.HK.Close          840  13    4.43      9.168  10.410           10.324
## X2318.HK.Close          841  12   30.35     58.600  64.350           65.138
## X2388.HK.Close          841  12    6.30     16.860  18.780           18.994
## X2600.HK.Close          841  12    3.17      4.400   6.820            6.442
## X2628.HK.Close          840  13   17.24     23.087  29.775           28.971
## X3328.HK.Close          841  12    4.17      5.940   7.880            7.457
## X3988.HK.Close          840  13    1.84      3.087   3.865            3.625
##                Geometric Mean Quartile 3 Maximum SE Mean LCL Mean (0.95)
## X0001.HK.Close         98.963     112.00  135.70  0.5415          99.178
## X0002.HK.Close         59.410      65.15   75.00  0.2289          59.320
## X0003.HK.Close         17.621      19.10   21.00  0.0719          17.614
## X0004.HK.Close         40.377      50.00   62.00  0.3689          41.261
```

```
## X0005.HK.Close          73.432      82.70   98.00  0.3960          73.626
## X0006.HK.Close          49.284      55.95   64.80  0.2170          49.239
## X0011.HK.Close         108.309     116.80  134.00  0.4224         108.196
## X0012.HK.Close          45.965      52.80   60.50  0.2746          46.189
## X0013.HK.Close          63.004      77.75   95.90  0.5422          63.825
## X0016.HK.Close         106.097     118.50  146.30  0.6121         106.548
## X0017.HK.Close          12.007      15.24   18.54  0.1141          12.233
## X0019.HK.Close          89.914     107.12  136.40  0.6644          90.865
## X0023.HK.Close          27.774      31.95   35.90  0.1689          27.944
## X0066.HK.Close          25.899      28.10   31.15  0.1086          25.896
## X0083.HK.Close          12.817      14.72   18.56  0.0831          12.901
## X0101.HK.Close          28.004      31.90   40.30  0.1859          28.191
## X0144.HK.Close          25.420      28.70   37.55  0.1687          25.590
## X0151.HK.Close           5.868       7.13    9.70  0.0529           5.945
## X0267.HK.Close          16.281      20.46   24.40  0.1371          16.498
## X0291.HK.Close          25.281      30.60   35.25  0.2182          25.800
## X0293.HK.Close          14.589      18.12   24.05  0.1352          14.814
## X0322.HK.Close          17.832      21.50   25.95  0.1533          18.158
## X0330.HK.Close          33.155      49.31   64.30  0.5340          36.310
## X0386.HK.Close           6.849       7.73    9.64  0.0393           6.859
## X0388.HK.Close         132.410     152.80  197.50  1.0027         134.061
## X0494.HK.Close          25.766      38.24   51.90  0.4020          27.368
## X0688.HK.Close          15.127      16.60   19.44  0.0654          15.118
## X0700.HK.Close         142.537     187.60  247.00  1.6879         149.845
## X0762.HK.Close          11.781      14.00   17.40  0.0845          11.835
## X0836.HK.Close          15.272      16.52   20.15  0.0565          15.242
## X0857.HK.Close           9.338      10.48   12.36  0.0497           9.350
## X0883.HK.Close          13.340      16.78   20.95  0.1175          13.537
## X0939.HK.Close           6.045       6.77    8.28  0.0313           6.047
## X0941.HK.Close          76.167      78.95   91.45  0.1551          75.993
## X1044.HK.Close          55.406      69.25   82.70  0.5074          56.687
## X1088.HK.Close          31.153      35.25   40.80  0.1949          31.387
## X1109.HK.Close          14.149      16.07   20.00  0.0864          14.201
## X1199.HK.Close          10.901      12.59   16.76  0.0786          10.968
## X1299.HK.Close          24.835      26.81   29.65  0.1105          24.709
## X1398.HK.Close           5.378       5.94    7.03  0.0287           5.381
## X1880.HK.Close          10.518      14.30   17.54  0.1305          10.996
## X1898.HK.Close          10.098      11.66   15.86  0.0741          10.178
## X2318.HK.Close          63.769      74.50   94.30  0.4473          64.260
## X2388.HK.Close          18.237      22.90   28.95  0.1728          18.654
## X2600.HK.Close           6.192       7.77   10.66  0.0636           6.317
## X2628.HK.Close          28.290      34.30   41.00  0.2142          28.551
## X3328.HK.Close           7.306       8.63   10.56  0.0537           7.352
## X3988.HK.Close           3.568       4.13    5.00  0.0240           3.578
##                UCL Mean (0.95)  Variance   Stdev Skewness Kurtosis
## X0001.HK.Close         101.304  246.6160 15.7040  -0.1391   0.0248
## X0002.HK.Close          60.218   44.0145  6.6343   0.1985  -1.3819
## X0003.HK.Close          17.896    4.3427  2.0839  -1.6403   2.2650
## X0004.HK.Close          42.709  114.3436 10.6932  -0.5374   0.0156
## X0005.HK.Close          75.180  131.8703 11.4835  -0.6705   0.1840
## X0006.HK.Close          50.091   39.6182  6.2943   0.4240  -1.1835
## X0011.HK.Close         109.854  150.0507 12.2495  -0.4395   0.0859
## X0012.HK.Close          47.267   63.4198  7.9637  -0.8360   0.3348
## X0013.HK.Close          65.954  246.9791 15.7156   0.2165  -1.0645
## X0016.HK.Close         108.951  315.1268 17.7518  -0.7881   0.5824
## X0017.HK.Close          12.681   10.9417  3.3078  -0.3390  -1.1210
## X0019.HK.Close          93.473  370.8187 19.2567  -0.4094   0.1845
```

```
## X0023.HK.Close          28.607   23.9534  4.8942  -1.2975   1.3978
## X0066.HK.Close          26.322    9.9142  3.1487  -1.4712   1.6200
## X0083.HK.Close          13.227    5.8006  2.4085  -1.0464   0.9693
## X0101.HK.Close          28.921   29.0677  5.3914  -0.5185   0.1971
## X0144.HK.Close          26.253   23.9109  4.8899  -0.5209   0.5251
## X0151.HK.Close           6.153    2.3545  1.5344  -0.1993  -0.4823
## X0267.HK.Close          17.037   15.7901  3.9737  -0.2627  -0.7901
## X0291.HK.Close          26.657   40.0585  6.3292  -1.1084   0.1819
## X0293.HK.Close          15.345   15.3649  3.9198   0.1857  -0.5986
## X0322.HK.Close          18.759   19.7533  4.4445  -0.8984  -0.0067
## X0330.HK.Close          38.406  239.5124 15.4762  -0.4734  -1.0020
## X0386.HK.Close           7.014    1.2946  1.1378  -0.3892   0.2754
## X0388.HK.Close         137.997  845.5740 29.0788  -0.5297   0.4602
## X0494.HK.Close          28.946  134.1193 11.5810   0.1559  -1.4527
## X0688.HK.Close          15.375    3.5880  1.8942  -0.8051   0.3253
## X0700.HK.Close         156.471 2418.9146 49.1825  -0.6609  -0.2544
## X0762.HK.Close          12.167    6.0418  2.4580   0.6007  -0.9920
## X0836.HK.Close          15.464    2.6805  1.6372   0.2598  -0.2526
## X0857.HK.Close           9.545    2.0733  1.4399  -0.7229   0.5902
## X0883.HK.Close          13.998   11.6000  3.4059  -0.1976  -0.7142
## X0939.HK.Close           6.170    0.8215  0.9064  -0.7292   0.2010
## X0941.HK.Close          76.602   20.2425  4.4992   0.1891   0.3348
## X1044.HK.Close          58.679  219.3707 14.8112  -0.7210  -0.4831
## X1088.HK.Close          32.151   31.8935  5.6474  -1.4569   1.7429
## X1109.HK.Close          14.540    6.2769  2.5054  -0.4077  -0.0039
## X1199.HK.Close          11.276    5.1890  2.2779   0.0677  -0.3692
## X1299.HK.Close          25.143    4.7356  2.1762   0.0681  -1.2060
## X1398.HK.Close           5.494    0.6942  0.8332  -0.8932   0.4210
## X1880.HK.Close          11.509   14.3136  3.7833  -0.5673  -0.7949
## X1898.HK.Close          10.469    4.6142  2.1481  -0.3866   0.2180
## X2318.HK.Close          66.016  168.2905 12.9727  -0.1583  -0.1605
## X2388.HK.Close          19.333   25.1007  5.0101  -0.5410  -0.1070
## X2600.HK.Close           6.567    3.4010  1.8442  -0.2621  -1.0827
## X2628.HK.Close          29.392   38.5230  6.2067  -0.2146  -1.1969
## X3328.HK.Close           7.563    2.4248  1.5572  -0.2793  -1.1287
## X3988.HK.Close           3.672    0.4839  0.6956  -0.6544  -0.4733
```

## 4.1 Higher Moments - Combined

```
##                 HSI Components to HSI Combined
## CoSkewness                              0.0000
## CoKurtosis                              0.0000
## Beta CoVariance                         0.0882
## Beta CoSkewness                         1.2178
## Beta CoKurtosis                        -0.0350
```

# 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     4.8468 1.41414 1.21449 1.17345 1.03554 0.99279
## Proportion of Variance 0.4894 0.04166 0.03073 0.02869 0.02234 0.02053
## Cumulative Proportion  0.4894 0.53107 0.56180 0.59049 0.61283 0.63336
##                         Comp.7  Comp.8  Comp.9 Comp.10 Comp.11 Comp.12
## Standard deviation     0.96399 0.93606 0.92637 0.90815  0.8762 0.84911
## Proportion of Variance 0.01936 0.01825 0.01788 0.01718  0.0160 0.01502
## Cumulative Proportion  0.65272 0.67097 0.68885 0.70603  0.7220 0.73705
##                        Comp.13 Comp.14 Comp.15 Comp.16 Comp.17 Comp.18
## Standard deviation     0.82452 0.80408 0.78249 0.75785 0.75007 0.74035
## Proportion of Variance 0.01416 0.01347 0.01276 0.01197 0.01172 0.01142
## Cumulative Proportion  0.75121 0.76468 0.77744 0.78940 0.80113 0.81254
##                        Comp.19 Comp.20 Comp.21  Comp.22  Comp.23  Comp.24
## Standard deviation      0.7301 0.70752 0.69396 0.680334 0.667004 0.653539
## Proportion of Variance  0.0111 0.01043 0.01003 0.009643 0.009269 0.008898
## Cumulative Proportion   0.8236 0.83408 0.84411 0.853754 0.863022 0.871921
##                         Comp.25  Comp.26  Comp.27  Comp.28  Comp.29
## Standard deviation     0.649078 0.630581 0.618064 0.610361 0.590081
## Proportion of Variance 0.008777 0.008284 0.007958 0.007761 0.007254
## Cumulative Proportion  0.880698 0.888982 0.896940 0.904701 0.911955
##                         Comp.30  Comp.31  Comp.32  Comp.33  Comp.34
## Standard deviation     0.582734 0.581779 0.568745 0.548890 0.529562
## Proportion of Variance 0.007075 0.007051 0.006739 0.006277 0.005842
## Cumulative Proportion  0.919030 0.926081 0.932820 0.939097 0.944939
##                         Comp.35 Comp.36  Comp.37  Comp.38  Comp.39
## Standard deviation     0.518798 0.51192 0.501467 0.484067 0.475139
## Proportion of Variance 0.005607 0.00546 0.005239 0.004882 0.004703
## Cumulative Proportion  0.950547 0.95601 0.961245 0.966127 0.970830
##                         Comp.40  Comp.41  Comp.42  Comp.43  Comp.44
## Standard deviation     0.463510 0.443424 0.427724 0.409324 0.392023
## Proportion of Variance 0.004476 0.004096 0.003811 0.003491 0.003202
## Cumulative Proportion  0.975306 0.979402 0.983214 0.986704 0.989906
##                         Comp.45  Comp.46 Comp.47  Comp.48
## Standard deviation     0.379662 0.351061 0.33798 0.320766
## Proportion of Variance 0.003003 0.002568 0.00238 0.002144
## Cumulative Proportion  0.992909 0.995477 0.99786 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        -0.206  0.110
## 0002.HK        -0.485         0.112 -0.202         0.196
## 0003.HK        -0.353 -0.104  0.225  0.110 -0.185               -0.218
## 0004.HK -0.163        -0.153
## 0005.HK -0.166               -0.106
## 0006.HK        -0.494        -0.104 -0.124         0.351
## 0011.HK -0.153        -0.174  0.184 -0.128                0.233
## 0012.HK -0.161        -0.210                       -0.129 -0.163 -0.192
## 0013.HK -0.165        -0.150
## 0016.HK -0.160        -0.255                              -0.203
## 0017.HK -0.146        -0.246                              -0.166
## 0019.HK -0.128                0.267               -0.221 -0.130  0.294
## 0023.HK -0.153                0.139 -0.190                0.210
## 0066.HK -0.140 -0.171         0.133               -0.102  0.101  0.220
## 0083.HK -0.155        -0.241                              -0.208 -0.185
```

```
## 0101.HK -0.154        -0.160                                 0.148
## 0144.HK -0.151                        0.127  0.176  0.156         0.102
## 0151.HK                0.382  0.358  0.108 -0.194 -0.155 -0.259
## 0267.HK -0.158                              -0.105                 0.143
## 0291.HK -0.130                               0.104  0.230 -0.289
## 0293.HK -0.126                0.133          0.284        -0.106  0.436
## 0322.HK                0.304  0.481                        0.204 -0.269
## 0330.HK                              0.392 -0.456  0.404         0.334
## 0386.HK -0.139 -0.221  0.139 -0.193  0.211  0.180 -0.238
## 0388.HK -0.174                              -0.119
## 0494.HK                      -0.122        -0.242  0.183  0.350  0.106
## 0688.HK -0.153  0.213        -0.102                0.185        -0.246
## 0700.HK -0.134         0.140        -0.229  0.232        -0.130  0.211
## 0762.HK -0.126 -0.133  0.289                0.146 -0.128
## 0836.HK                       0.142  0.685  0.239         0.233
## 0857.HK -0.158 -0.143  0.113 -0.168  0.128        -0.168
## 0883.HK -0.169               -0.129
## 0939.HK -0.176                                    -0.132
## 0941.HK -0.120 -0.283  0.147                      -0.142 -0.204
## 1044.HK -0.101         0.308  0.272 -0.155  0.179  0.188 -0.137  0.113
## 1088.HK -0.168         0.116
## 1109.HK -0.151  0.249                             0.130        -0.182
## 1199.HK -0.156               -0.198                0.149
## 1299.HK -0.129                                   0.305  0.162  0.337 -0.192
## 1398.HK -0.181
## 1880.HK -0.127         0.155                      0.205  0.297 -0.154
## 1898.HK -0.163                                   -0.189         0.128  0.101
## 2318.HK -0.169               -0.109                       -0.128
## 2388.HK -0.160                      -0.163                 0.162  0.121
## 2600.HK -0.159               -0.123        -0.124
## 2628.HK -0.162               -0.122        -0.179 -0.107
## 3328.HK -0.175               -0.111
## 3988.HK -0.177                                    -0.101  0.111
##         Comp.10 Comp.11 Comp.12 Comp.13 Comp.14 Comp.15 Comp.16 Comp.17
## 0001.HK                                                  0.137
## 0002.HK -0.122   0.127           0.120  -0.156          -0.190
## 0003.HK         -0.286                   0.349                   0.249
## 0004.HK                         0.180  -0.113
## 0005.HK                 -0.205
## 0006.HK          0.459   0.124                  -0.122   0.178
## 0011.HK         -0.109           0.137                          0.195
## 0012.HK                                 -0.182
## 0013.HK                                  0.165   0.140   0.101
## 0016.HK  0.132                  0.111  -0.110
## 0017.HK  0.184   0.161  -0.271                  -0.184          -0.108
## 0019.HK          0.145   0.260           0.263  -0.198  -0.177  -0.341
## 0023.HK -0.178  -0.115   0.186          -0.116   0.141   0.114
## 0066.HK         -0.203  -0.144          -0.180   0.191   0.120  -0.240
## 0083.HK                                 -0.295
## 0101.HK  0.112  -0.111   0.120                  -0.178           0.329
## 0144.HK  0.207          -0.152                   0.157          -0.136
## 0151.HK  0.200                  0.296                   0.238   0.120
## 0267.HK                         0.169           0.196  -0.231  -0.105
## 0291.HK         -0.173   0.171  -0.507                  -0.285
## 0293.HK          0.155          -0.197                          0.279
## 0322.HK          0.294  -0.218  -0.209           0.319  -0.254
## 0330.HK -0.187  -0.156  -0.198   0.103  -0.139  -0.109           0.189
```

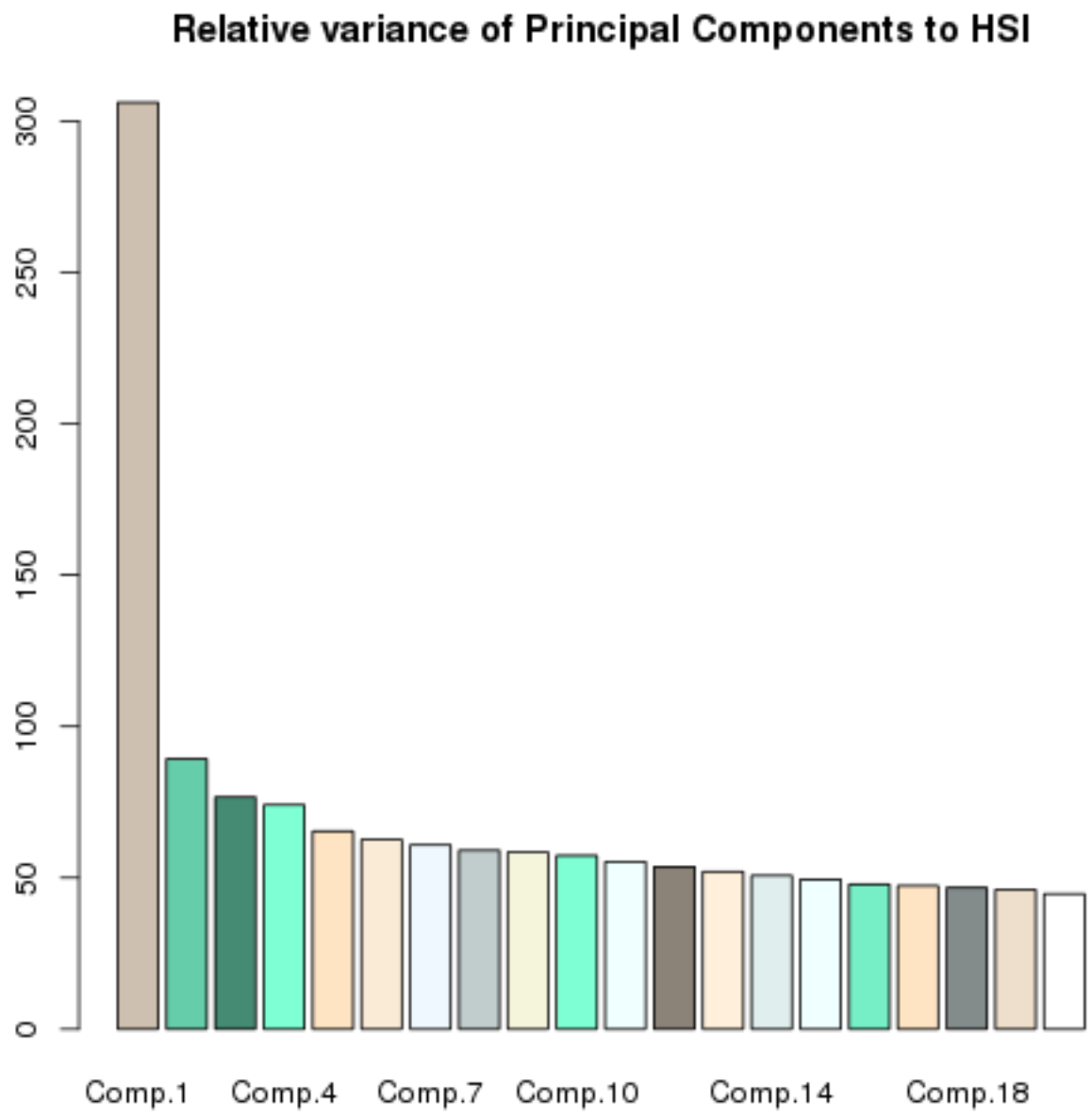
```
## 0386.HK                                                  -0.144   0.138
## 0388.HK                -0.130
## 0494.HK  0.688          0.306
## 0688.HK -0.219          0.227   0.107          0.129
## 0700.HK                         0.204  -0.112   0.220   0.206   0.320
## 0762.HK                 0.107   0.239  -0.287  -0.197  -0.282  -0.132
## 0836.HK          0.273  0.207          -0.168          0.252
## 0857.HK  0.101                                          -0.201   0.268
## 0883.HK                                                 -0.120   0.121
## 0939.HK                -0.134  -0.190                   0.161
## 0941.HK -0.114  -0.309         -0.137  -0.120   0.292   0.190  -0.236
## 1044.HK  0.156  -0.178         -0.156  -0.284  -0.459
## 1088.HK                 0.114   0.117   0.107
## 1109.HK -0.205          0.327
## 1199.HK  0.134         -0.303                   0.139          -0.158
## 1299.HK         -0.249  -0.278   0.178   0.134  -0.193  -0.152  -0.152
## 1398.HK -0.113   0.102         -0.166          -0.111   0.109
## 1880.HK         -0.165          0.180   0.422          0.117  -0.227
## 1898.HK                                 0.120                  -0.110
## 2318.HK                 0.114
## 2388.HK -0.119                          0.141  -0.155   0.127
## 2600.HK          0.133                                  -0.249
## 2628.HK
## 3328.HK -0.101                  -0.147          -0.167   0.198
## 3988.HK                         -0.277                   0.199
##         Comp.18 Comp.19 Comp.20 Comp.21 Comp.22 Comp.23 Comp.24 Comp.25
## 0001.HK                                                  0.146
## 0002.HK                 -0.172          -0.186  -0.134          -0.166
## 0003.HK  0.122           0.373  -0.215  -0.103   0.200          -0.129
## 0004.HK -0.207          -0.121  -0.155          -0.209   0.243   0.150
## 0005.HK                  0.255  -0.130                   0.219   0.244
## 0006.HK                                                          0.155
## 0011.HK         -0.137          0.102                   -0.137   0.129
## 0012.HK          0.103  -0.192                           0.110
## 0013.HK                 -0.111          0.204           0.173  -0.154
## 0016.HK                         0.155   0.142   0.147
## 0017.HK  0.129                          -0.117  -0.231  -0.101  -0.102
## 0019.HK          0.136   0.192          0.188   0.139  -0.188
## 0023.HK         -0.255          0.175   0.124   0.156          0.309
## 0066.HK -0.332          -0.116          -0.254          -0.343
## 0083.HK                                         0.239          0.142
## 0101.HK                 -0.252                  -0.222  -0.173   0.106
## 0144.HK         -0.284   0.197   0.162                          -0.174
## 0151.HK         -0.271                          -0.235          0.227
## 0267.HK                                          0.170          -0.126
## 0291.HK         -0.351  -0.136  -0.310   0.117
## 0293.HK  0.214   0.169   0.196   0.167  -0.295  -0.217   0.230   0.169
## 0322.HK          0.255
## 0330.HK  0.167   0.137                   0.157
## 0386.HK -0.147                  0.134                   -0.216  -0.120
## 0388.HK         -0.104          -0.173  -0.180                  -0.109
## 0494.HK  0.175   0.144
## 0688.HK                 0.200   0.146                          -0.198
## 0700.HK                         -0.401   0.281          -0.379
## 0762.HK  0.437                  -0.217  -0.199
## 0836.HK                         -0.191
## 0857.HK -0.245                   0.198          0.137
```

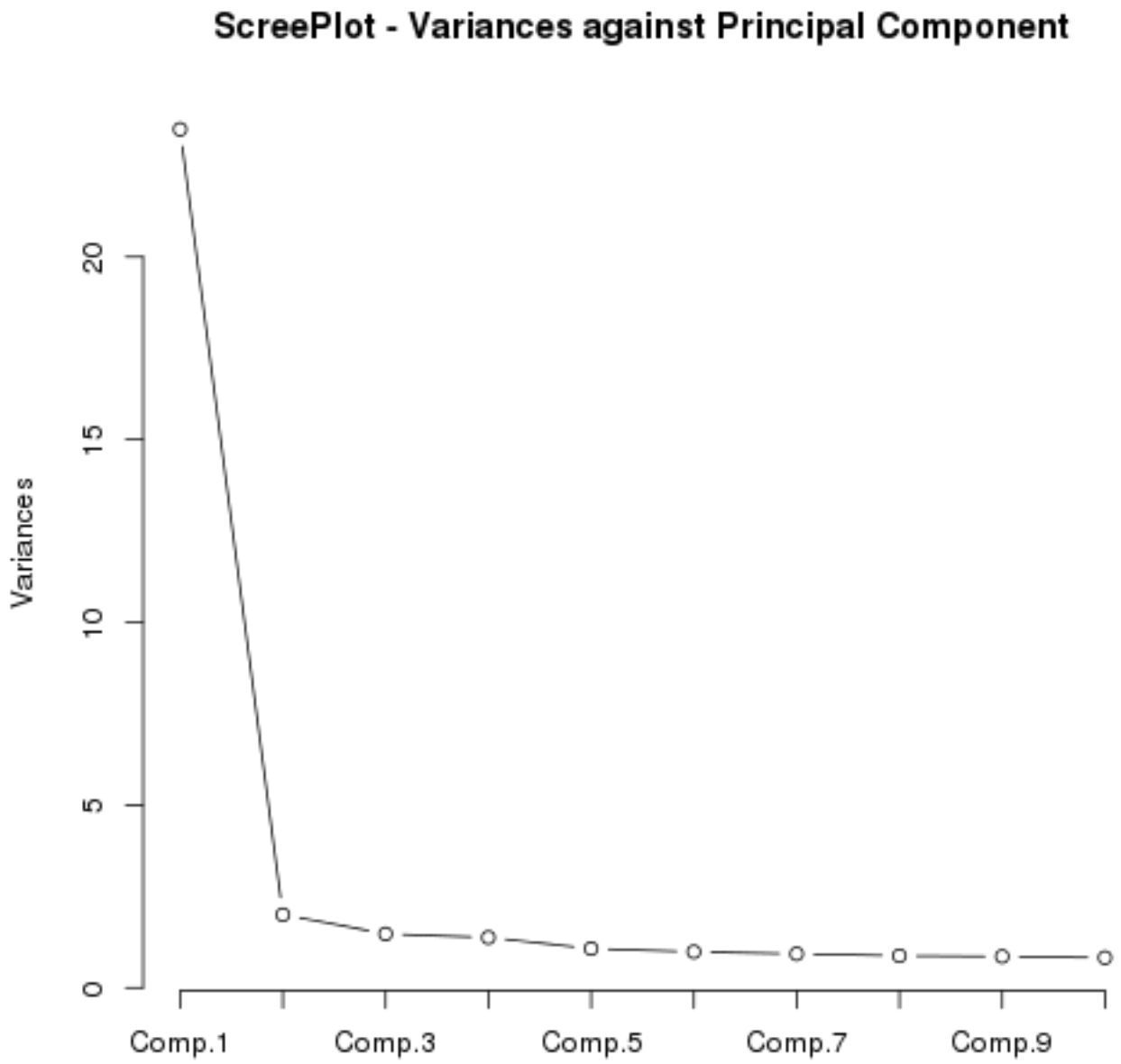
```
## 0883.HK                          0.131           0.363   0.248
## 0939.HK  0.201                                                  -0.135
## 0941.HK  0.159   0.251           0.118   0.162  -0.404   0.112
## 1044.HK -0.335   0.104   0.146                   0.108   0.108  -0.204
## 1088.HK         -0.219                   0.268           0.192
## 1109.HK                  0.255   0.116  -0.130  -0.103          -0.196
## 1199.HK -0.101  -0.142   0.230
## 1299.HK          0.160   0.213           0.253  -0.188           0.135
## 1398.HK
## 1880.HK          0.222  -0.405          -0.334   0.239           0.126
## 1898.HK                 -0.150   0.113   0.255           0.133
## 2318.HK          0.236          -0.296
## 2388.HK  0.117  -0.197                   -0.104           0.135  -0.440
## 2600.HK         -0.160                                  -0.181  -0.337   0.140
## 2628.HK -0.303   0.220   0.123  -0.340                   0.129   0.171
## 3328.HK                                                          0.205
## 3988.HK  0.139
##         Comp.26 Comp.27 Comp.28 Comp.29 Comp.30 Comp.31 Comp.32 Comp.33
## 0001.HK -0.122   0.103                                           -0.109
## 0002.HK -0.117  -0.213          -0.137  -0.262  -0.102           0.325
## 0003.HK  0.115          -0.139   0.150  -0.174   0.109
## 0004.HK         -0.176  -0.362   0.217   0.196   0.142   0.174  -0.108
## 0005.HK                  0.292          -0.157  -0.220           0.158
## 0006.HK          0.125                   0.212          -0.167  -0.206
## 0011.HK  0.203           0.180           0.479                   0.212
## 0012.HK  0.181   0.149  -0.206                   -0.164           0.191
## 0013.HK -0.224   0.259  -0.132   0.142  -0.175  -0.106  -0.357
## 0016.HK                  0.120  -0.129                   0.379  -0.297
## 0017.HK         -0.211   0.360   0.175           0.384  -0.330
## 0019.HK -0.208  -0.287                           -0.150           0.151
## 0023.HK         -0.164           0.315           0.138          -0.145
## 0066.HK          0.133          -0.168  -0.147          -0.220  -0.158
## 0083.HK          0.137   0.143                                   0.153
## 0101.HK  0.168  -0.431                   -0.176  -0.123          -0.199
## 0144.HK  0.363  -0.124  -0.163           0.136  -0.264  -0.173   0.222
## 0151.HK -0.118                  -0.292
## 0267.HK  0.493          -0.113  -0.185           0.385          -0.116
## 0291.HK                  0.106  -0.231   0.139
## 0293.HK          0.222          -0.129  -0.141
## 0322.HK                          0.100          -0.169          -0.111
## 0330.HK -0.133
## 0386.HK          0.193                   0.193  -0.143          -0.172
## 0388.HK          0.136           0.188   0.144           0.103
## 0494.HK
## 0688.HK -0.109                  -0.111                   -0.110
## 0700.HK
## 0762.HK                                                  -0.131  -0.293
## 0836.HK                  0.158                           0.168   0.144
## 0857.HK -0.183                           0.139   0.165
## 0883.HK -0.236  -0.126                           0.294           0.284
## 0939.HK                 -0.193
## 0941.HK                          0.150   0.135   0.128   0.160   0.111
## 1044.HK  0.137                   0.186
## 1088.HK  0.223           0.215          -0.155  -0.243  -0.123
## 1109.HK
## 1199.HK         -0.213          -0.183  -0.137           0.352  -0.209
## 1299.HK -0.141   0.131  -0.114  -0.271           0.151           0.112
```

```
## 1398.HK                 -0.132
## 1880.HK                         0.127
## 1898.HK  0.121   0.277   0.239         -0.326   0.217   0.260
## 2318.HK                 -0.223  -0.111   0.133                   0.122
## 2388.HK                  0.192          0.254  -0.108   0.180
## 2600.HK          0.301           0.438  -0.147           0.189   0.225
## 2628.HK  0.179           0.220  -0.101
## 3328.HK                                                         0.102
## 3988.HK                 -0.163
##         Comp.34 Comp.35 Comp.36 Comp.37 Comp.38 Comp.39 Comp.40 Comp.41
## 0001.HK  0.242                   0.230           0.124           0.219
## 0002.HK                 -0.237   0.257                   -0.123
## 0003.HK                          -0.143
## 0004.HK -0.172  -0.288           -0.187           0.257   0.161   0.204
## 0005.HK -0.372           0.414   0.207   0.218   0.199   0.124
## 0006.HK          0.121   0.228                           0.104
## 0011.HK  0.128  -0.240   0.258                   -0.184  -0.277
## 0012.HK                  0.197          -0.351   0.158          -0.420
## 0013.HK                                  0.139  -0.168  -0.308
## 0016.HK  0.208                   0.251           -0.165   0.270   0.145
## 0017.HK                                  -0.196                  -0.124
## 0019.HK
## 0023.HK          0.224  -0.303   0.191           0.109          -0.210
## 0066.HK                  0.110  -0.228                   0.227
## 0083.HK -0.264   0.150  -0.389  -0.414   0.166          -0.155   0.217
## 0101.HK          0.206   0.128  -0.119   0.323
## 0144.HK  0.249           -0.142           0.144   0.192   0.235
## 0151.HK          0.131
## 0267.HK -0.237   0.148   0.106   0.254                           0.202
## 0291.HK                          0.105
## 0293.HK
## 0322.HK                         -0.129           0.113
## 0330.HK
## 0386.HK -0.225  -0.182  -0.195   0.169           0.216  -0.259
## 0388.HK -0.234           -0.229           0.198  -0.337   0.172  -0.404
## 0494.HK -0.101
## 0688.HK          -0.181                   0.127   0.110
## 0700.HK                                  -0.128           0.145
## 0762.HK  0.219                   -0.152   0.106
## 0836.HK
## 0857.HK          0.215                   -0.153
## 0883.HK  0.135           0.114  -0.176   0.132  -0.193   0.105
## 0939.HK -0.159  -0.125                   0.172  -0.238           0.159
## 0941.HK                  0.115  -0.109           -0.108
## 1044.HK
## 1088.HK -0.180  -0.167           -0.181  -0.408  -0.394           0.160
## 1109.HK -0.118                                                   -0.157
## 1199.HK                          -0.117  -0.151  -0.108  -0.466  -0.138
## 1299.HK                                                  0.154
## 1398.HK                          0.115  -0.105           0.148
## 1880.HK
## 1898.HK  0.130  -0.167           -0.159   0.297   0.248          -0.258
## 2318.HK  0.128   0.235           -0.132                   -0.242  -0.169
## 2388.HK          0.396           -0.172  -0.142   0.227           0.210
## 2600.HK  0.175   0.312   0.135                                   0.250
## 2628.HK  0.366           -0.297   0.145
## 3328.HK          -0.351                   -0.242   0.291  -0.150   0.181
```

```
## 3988.HK                          0.176
##         Comp.42 Comp.43 Comp.44 Comp.45 Comp.46 Comp.47 Comp.48
## 0001.HK  0.251  -0.171   0.183   0.458   0.407  -0.251
## 0002.HK
## 0003.HK -0.104
## 0004.HK -0.112  -0.109  -0.209
## 0005.HK -0.173
## 0006.HK  0.108
## 0011.HK         -0.186
## 0012.HK  0.224          -0.229          -0.151          -0.127
## 0013.HK                         -0.332  -0.269   0.171   0.110
## 0016.HK -0.278   0.102   0.137  -0.274           0.107  -0.107
## 0017.HK -0.142
## 0019.HK  0.165
## 0023.HK          0.114           0.115                  -0.127
## 0066.HK -0.146
## 0083.HK                                                  0.106
## 0101.HK          0.150   0.135
## 0144.HK
## 0151.HK
## 0267.HK  0.116           0.117
## 0291.HK
## 0293.HK
## 0322.HK
## 0330.HK
## 0386.HK -0.136   0.296  -0.139   0.123          -0.107
## 0388.HK  0.238           0.408                  -0.135
## 0494.HK
## 0688.HK                  0.123   0.176  -0.524  -0.228  -0.220
## 0700.HK
## 0762.HK
## 0836.HK
## 0857.HK  0.108  -0.566   0.189  -0.127  -0.101   0.129
## 0883.HK          0.494  -0.116           0.161
## 0939.HK         -0.105  -0.216   0.287           0.515  -0.376
## 0941.HK
## 1044.HK
## 1088.HK                          0.186          -0.122
## 1109.HK                 -0.107  -0.254   0.510   0.252   0.202
## 1199.HK  0.114                   0.104
## 1299.HK
## 1398.HK -0.131           0.108   0.188  -0.244   0.114   0.767
## 1880.HK         -0.104
## 1898.HK         -0.173  -0.109
## 2318.HK -0.570           0.229           0.116          -0.178
## 2388.HK  0.101   0.172
## 2600.HK
## 2628.HK  0.259          -0.297          -0.135   0.109
## 3328.HK  0.237   0.189   0.435  -0.326           0.137  -0.142
## 3988.HK         -0.208  -0.299  -0.373          -0.602
##
##                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  0.062  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   0.313
##                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
300
250
200
150
100
50
0
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)

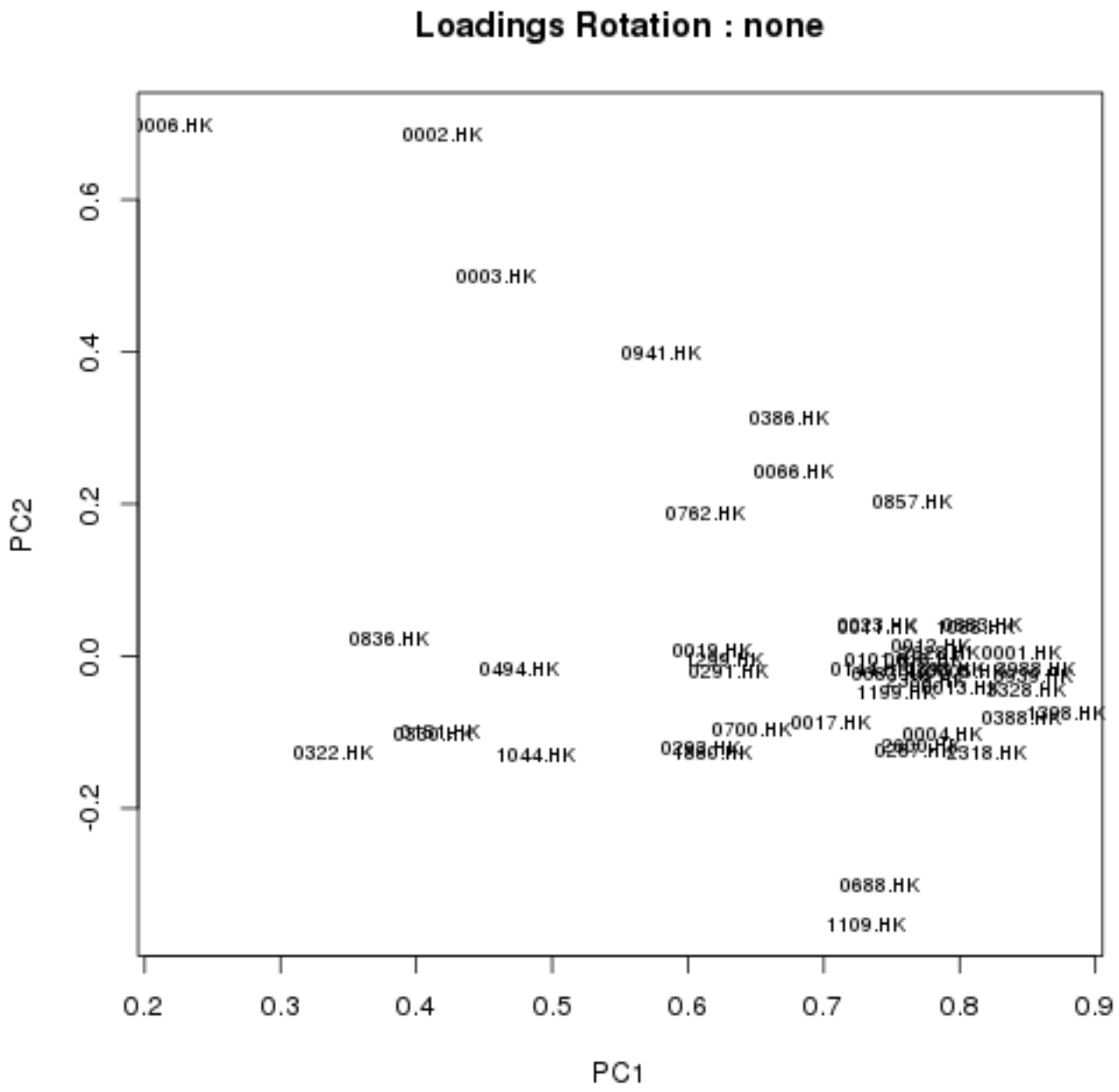
[7] http://en.wikipedia.org/wiki/Factoranalysis

### 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 0.88 -0.07  0.09 -0.11 -0.07 0.80 0.20
## 3988.HK   48 0.86 -0.02  0.09 -0.08  0.00 0.75 0.25
## 0939.HK   33 0.86 -0.03  0.12 -0.07 -0.02 0.75 0.25
## 3328.HK   47 0.85 -0.05  0.07 -0.13  0.01 0.75 0.25
## 0001.HK    1 0.85  0.01 -0.25  0.13 -0.03 0.80 0.20
## 0388.HK   25 0.85 -0.08 -0.10  0.04 -0.06 0.74 0.26
## 2318.HK   43 0.82 -0.13  0.02 -0.13 -0.08 0.71 0.29
## 0883.HK   32 0.82  0.04  0.12 -0.15 -0.02 0.71 0.29
## 1088.HK   36 0.81  0.04  0.14 -0.07  0.05 0.69 0.31
## 0005.HK    5 0.81 -0.02 -0.01 -0.12 -0.03 0.67 0.33
## 0013.HK    9 0.80 -0.04 -0.18  0.11  0.00 0.69 0.31
## 1898.HK   42 0.79 -0.02  0.07 -0.11 -0.03 0.64 0.36
## 0004.HK    4 0.79 -0.10 -0.19  0.04 -0.04 0.67 0.33
## 2628.HK   46 0.79  0.00  0.05 -0.14 -0.05 0.64 0.36
## 0012.HK    8 0.78  0.01 -0.26  0.08  0.01 0.68 0.32
## 2388.HK   44 0.78 -0.03 -0.03  0.06 -0.17 0.64 0.36
## 0016.HK   10 0.77  0.00 -0.31  0.04 -0.08 0.70 0.30
## 2600.HK   45 0.77 -0.12  0.06 -0.14 -0.03 0.64 0.36
## 0267.HK   19 0.77 -0.13  0.05  0.08  0.07 0.62 0.38
## 0857.HK   31 0.77  0.20  0.14 -0.20  0.13 0.70 0.30
## 1199.HK   38 0.75 -0.05  0.02 -0.23  0.05 0.63 0.37
## 0083.HK   15 0.75 -0.02 -0.29  0.02  0.01 0.65 0.35
## 0101.HK   16 0.74  0.00 -0.19  0.01  0.06 0.60 0.40
## 0688.HK   27 0.74 -0.30  0.02 -0.12 -0.06 0.66 0.34
## 0011.HK    7 0.74  0.04 -0.21  0.22 -0.13 0.66 0.34
## 0023.HK   13 0.74  0.04 -0.04  0.16 -0.20 0.62 0.38
## 0144.HK   17 0.73 -0.02  0.08 -0.11  0.13 0.57 0.43
## 1109.HK   37 0.73 -0.35  0.00 -0.10  0.00 0.67 0.33
## 0017.HK   11 0.71 -0.09 -0.30  0.02  0.03 0.60 0.40
## 0066.HK   14 0.68  0.24 -0.11  0.16  0.03 0.56 0.44
## 0386.HK   24 0.68  0.31  0.17 -0.23  0.22 0.68 0.32
## 0700.HK   28 0.65 -0.10  0.17 -0.07 -0.24 0.52 0.48
## 0291.HK   20 0.63 -0.02 -0.03  0.07  0.08 0.41 0.59
## 1299.HK   39 0.63  0.00 -0.01  0.04  0.04 0.40 0.60
## 0019.HK   12 0.62  0.01 -0.09  0.31  0.01 0.49 0.51
## 1880.HK   41 0.62 -0.13  0.19 -0.03 -0.01 0.43 0.57
## 0762.HK   29 0.61  0.19  0.35 -0.12  0.04 0.55 0.45
## 0293.HK   21 0.61 -0.12 -0.10  0.16 -0.04 0.42 0.58
## 0941.HK   34 0.58  0.40  0.18 -0.03  0.07 0.53 0.47
## 1044.HK   35 0.49 -0.13  0.37  0.32 -0.16 0.52 0.48
## 0494.HK   26 0.48 -0.02  0.07 -0.14 -0.08 0.26 0.74
## 0330.HK   23 0.41 -0.10  0.03 -0.04  0.41 0.35 0.65
## 0006.HK    6 0.22  0.70  0.03 -0.12 -0.13 0.57 0.43
## 0002.HK    2 0.42  0.69  0.00  0.13 -0.21 0.71 0.29
## 0003.HK    3 0.46  0.50 -0.13  0.26  0.11 0.56 0.44
## 0151.HK   18 0.42 -0.10  0.46  0.42  0.11 0.59 0.41
## 0322.HK   22 0.34 -0.13  0.37  0.56 -0.02 0.59 0.41
## 0836.HK   30 0.38  0.02 -0.10  0.17  0.71 0.69 0.31
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    23.49 2.00 1.47 1.38 1.07
```

```
## Proportion Var  0.49 0.04 0.03 0.03 0.02
## Cumulative Var  0.49 0.53 0.56 0.59 0.61
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  38.58 0.3
## The degrees of freedom for the model are 898  and the objective function was  5.5
##  0.3The number of observations was  377  with Chi Square =  1956  with prob <  1.7e-80
##  0.3
## Fit based upon off diagonal values = 0.99
##             PC1       PC2
## 0001.HK 0.8460  0.005485
## 0002.HK 0.4192  0.685698
## 0003.HK 0.4586  0.499516
## 0004.HK 0.7881 -0.101910
## 0005.HK 0.8052 -0.021149
## 0006.HK 0.2215  0.698521
## 0011.HK 0.7398  0.037135
## 0012.HK 0.7796  0.014755
## 0013.HK 0.8017 -0.040207
## 0016.HK 0.7736 -0.003052
## 0017.HK 0.7060 -0.085865
## 0019.HK 0.6185  0.008588
## 0023.HK 0.7394  0.042575
## 0066.HK 0.6784  0.242322
## 0083.HK 0.7493 -0.021713
## 0101.HK 0.7448 -0.003324
## 0144.HK 0.7341 -0.018297
## 0151.HK 0.4183 -0.100718
## 0267.HK 0.7669 -0.125068
## 0291.HK 0.6298 -0.018989
## 0293.HK 0.6088 -0.119596
## 0322.HK 0.3382 -0.126510
## 0330.HK 0.4123 -0.101396
## 0386.HK 0.6753  0.312666
## 0388.HK 0.8454 -0.081087
## 0494.HK 0.4761 -0.017085
## 0688.HK 0.7421 -0.301657
## 0700.HK 0.6474 -0.095591
## 0762.HK 0.6128  0.187398
## 0836.HK 0.3792  0.021485
## 0857.HK 0.7651  0.202313
## 0883.HK 0.8168  0.040469
## 0939.HK 0.8551 -0.025183
## 0941.HK 0.5798  0.400089
## 1044.HK 0.4881 -0.129797
## 1088.HK 0.8121  0.036813
## 1109.HK 0.7311 -0.352130
## 1199.HK 0.7541 -0.046636
## 1299.HK 0.6261 -0.003726
## 1398.HK 0.8790 -0.074956
## 1880.HK 0.6180 -0.126445
## 1898.HK 0.7886 -0.016658
## 2318.HK 0.8200 -0.125319
## 2388.HK 0.7757 -0.032641
## 2600.HK 0.7721 -0.116199
## 2628.HK 0.7858  0.004311
```

```
## 3328.HK 0.8496 -0.045245
## 3988.HK 0.8555 -0.018079
```



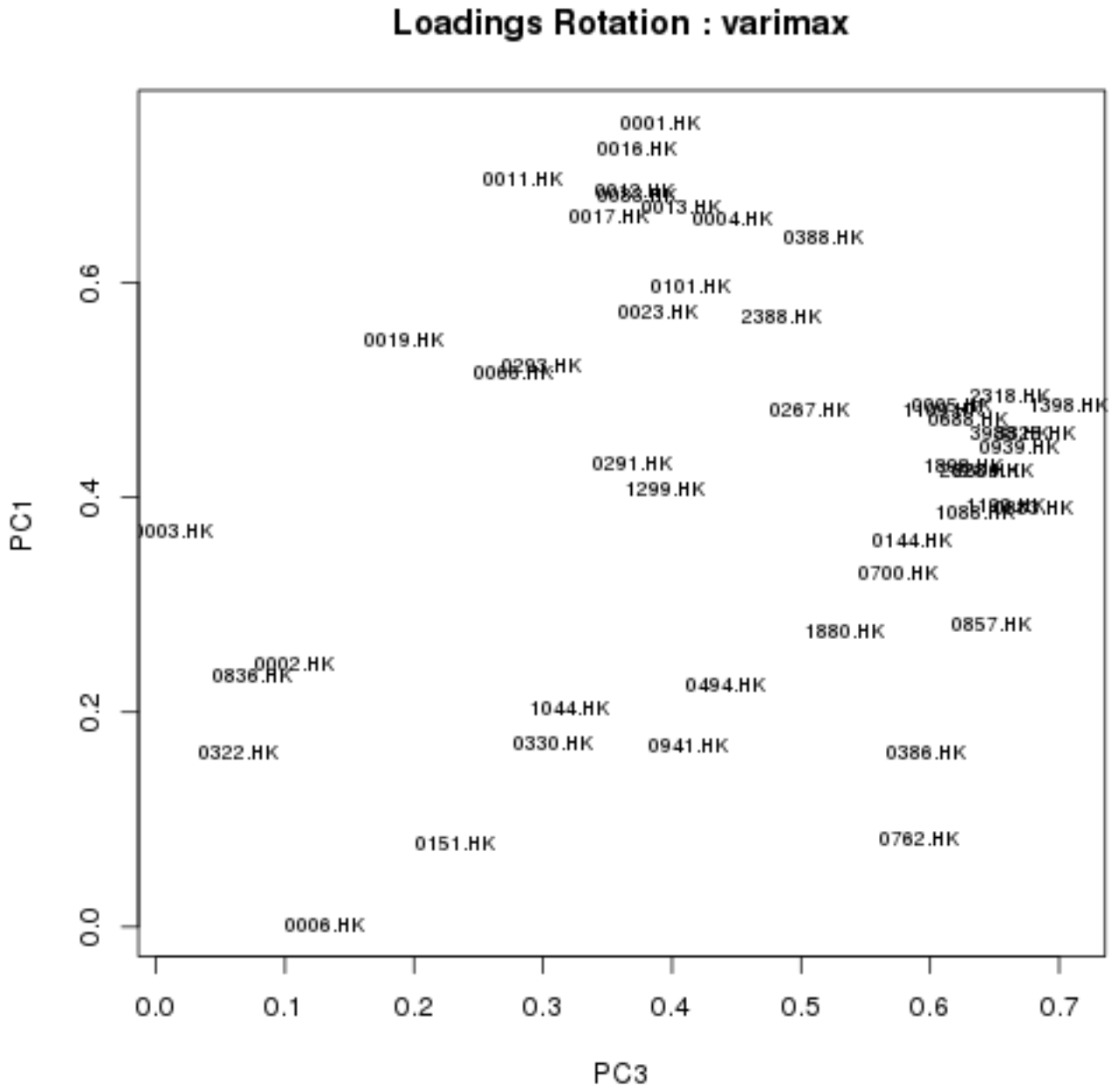
### 5.2.2 Rotation : varimax

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  PC3  PC1   PC2   PC4   PC5   h2   u2
## 1398.HK   40 0.71 0.49  0.14  0.20  0.08 0.80 0.20
## 3328.HK   47 0.68 0.46  0.15  0.15  0.15 0.75 0.25
## 0883.HK   32 0.68 0.39  0.23  0.15  0.12 0.71 0.29
## 0939.HK   33 0.67 0.45  0.18  0.23  0.13 0.75 0.25
## 3988.HK   48 0.66 0.46  0.19  0.20  0.14 0.75 0.25
## 2318.HK   43 0.66 0.49  0.07  0.14  0.06 0.71 0.29
## 1199.HK   38 0.66 0.39  0.12  0.02  0.16 0.63 0.37
## 2600.HK   45 0.65 0.43  0.07  0.13  0.10 0.64 0.36
## 0857.HK   31 0.65 0.28  0.36  0.08  0.25 0.70 0.30
## 2628.HK   46 0.64 0.42  0.19  0.12  0.08 0.64 0.36
## 1088.HK   36 0.63 0.39  0.23  0.22  0.19 0.69 0.31
## 0688.HK   27 0.63 0.47 -0.12  0.15  0.06 0.66 0.34
## 1898.HK   42 0.63 0.43  0.17  0.16  0.10 0.64 0.36
## 0005.HK    5 0.62 0.49  0.16  0.10  0.10 0.67 0.33
## 1109.HK   37 0.61 0.48 -0.17  0.15  0.12 0.67 0.33
## 0386.HK   24 0.60 0.16  0.44  0.03  0.32 0.68 0.32
## 0762.HK   29 0.59 0.08  0.34  0.24  0.13 0.55 0.45
## 0144.HK   17 0.59 0.36  0.15  0.14  0.25 0.57 0.43
## 0700.HK   28 0.57 0.33  0.09  0.24 -0.13 0.52 0.48
## 1880.HK   41 0.53 0.27  0.04  0.26  0.08 0.43 0.57
## 0267.HK   19 0.51 0.48  0.06  0.28  0.21 0.62 0.38
## 0494.HK   26 0.44 0.23  0.10  0.06  0.00 0.26 0.74
## 0001.HK    1 0.39 0.75  0.20  0.14  0.15 0.80 0.20
## 0016.HK   10 0.37 0.73  0.17  0.03  0.08 0.70 0.30
## 0011.HK    7 0.28 0.70  0.22  0.21  0.03 0.66 0.34
## 0012.HK    8 0.37 0.69  0.19  0.08  0.17 0.68 0.32
## 0083.HK   15 0.37 0.68  0.14  0.02  0.16 0.65 0.35
## 0013.HK    9 0.41 0.67  0.15  0.16  0.16 0.69 0.31
## 0017.HK   11 0.35 0.66  0.06  0.01  0.17 0.60 0.40
## 0004.HK    4 0.45 0.66  0.08  0.12  0.12 0.67 0.33
## 0388.HK   25 0.52 0.64  0.12  0.18  0.10 0.74 0.26
## 0101.HK   16 0.41 0.60  0.16  0.06  0.20 0.60 0.40
## 0023.HK   13 0.39 0.57  0.24  0.28 -0.04 0.62 0.38
## 2388.HK   44 0.48 0.57  0.17  0.22 -0.02 0.64 0.36
## 0019.HK   12 0.19 0.55  0.17  0.32  0.15 0.49 0.51
## 0293.HK   21 0.30 0.52  0.04  0.22  0.09 0.42 0.58
## 0066.HK   14 0.28 0.52  0.39  0.17  0.17 0.56 0.44
## 0291.HK   20 0.37 0.43  0.13  0.17  0.20 0.41 0.59
## 1299.HK   39 0.39 0.41  0.14  0.17  0.16 0.40 0.60
## 0002.HK    2 0.11 0.24  0.78  0.10 -0.10 0.71 0.29
## 0006.HK    6 0.13 0.00  0.73 -0.12 -0.08 0.57 0.43
## 0003.HK    3 0.01 0.37  0.59  0.14  0.24 0.56 0.44
## 0941.HK   34 0.41 0.17  0.53  0.16  0.18 0.53 0.47
## 0322.HK   22 0.06 0.16  0.02  0.74  0.06 0.59 0.41
## 0151.HK   18 0.23 0.08  0.05  0.70  0.19 0.59 0.41
## 1044.HK   35 0.32 0.20  0.05  0.61 -0.07 0.52 0.48
```

```
## 0836.HK   30 0.07 0.23  0.06  0.10  0.78 0.69 0.31
## 0330.HK   23 0.31 0.17 -0.03  0.08  0.46 0.35 0.65
##
##                  PC3   PC1  PC2  PC4  PC5
## SS loadings    11.42 10.32 3.20 2.66 1.82
## Proportion Var  0.24  0.22 0.07 0.06 0.04
## Cumulative Var  0.24  0.45 0.52 0.57 0.61
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  38.58 0.3
## The degrees of freedom for the model are 898  and the objective function was  5.5
##  0.3The number of observations was  377  with Chi Square =  1956  with prob <  1.7e-80
##  0.3
## Fit based upon off diagonal values = 0.99
##             PC3      PC1
## 0001.HK 0.39127 0.748851
## 0002.HK 0.10658 0.244117
## 0003.HK 0.01418 0.367607
## 0004.HK 0.44655 0.658963
## 0005.HK 0.61741 0.485854
## 0006.HK 0.13089 0.002324
## 0011.HK 0.28438 0.696129
## 0012.HK 0.37068 0.686019
## 0013.HK 0.40735 0.671222
## 0016.HK 0.37386 0.725203
## 0017.HK 0.35140 0.662184
## 0019.HK 0.19254 0.546402
## 0023.HK 0.38957 0.571926
## 0066.HK 0.27731 0.516552
## 0083.HK 0.37285 0.681024
## 0101.HK 0.41471 0.596147
## 0144.HK 0.58591 0.358963
## 0151.HK 0.23156 0.078717
## 0267.HK 0.50735 0.481899
## 0291.HK 0.36985 0.431083
## 0293.HK 0.29914 0.522250
## 0322.HK 0.06422 0.163391
## 0330.HK 0.30825 0.171838
## 0386.HK 0.59622 0.162653
## 0388.HK 0.51686 0.641118
## 0494.HK 0.44122 0.225448
## 0688.HK 0.62991 0.473118
## 0700.HK 0.57459 0.328881
## 0762.HK 0.59171 0.083186
## 0836.HK 0.07437 0.234649
## 0857.HK 0.64829 0.280767
## 0883.HK 0.68077 0.390312
## 0939.HK 0.67018 0.447352
## 0941.HK 0.41240 0.169436
## 1044.HK 0.32016 0.203606
## 1088.HK 0.63452 0.385827
## 1109.HK 0.60880 0.482026
## 1199.HK 0.65833 0.392042
## 1299.HK 0.39478 0.406789
## 1398.HK 0.70795 0.486213
## 1880.HK 0.53312 0.274992
```

```
## 1898.HK 0.62646 0.428527
## 2318.HK 0.66222 0.494627
## 2388.HK 0.48497 0.568258
## 2600.HK 0.65011 0.425269
## 2628.HK 0.63802 0.424943
## 3328.HK 0.68220 0.458838
## 3988.HK 0.66253 0.460539
```



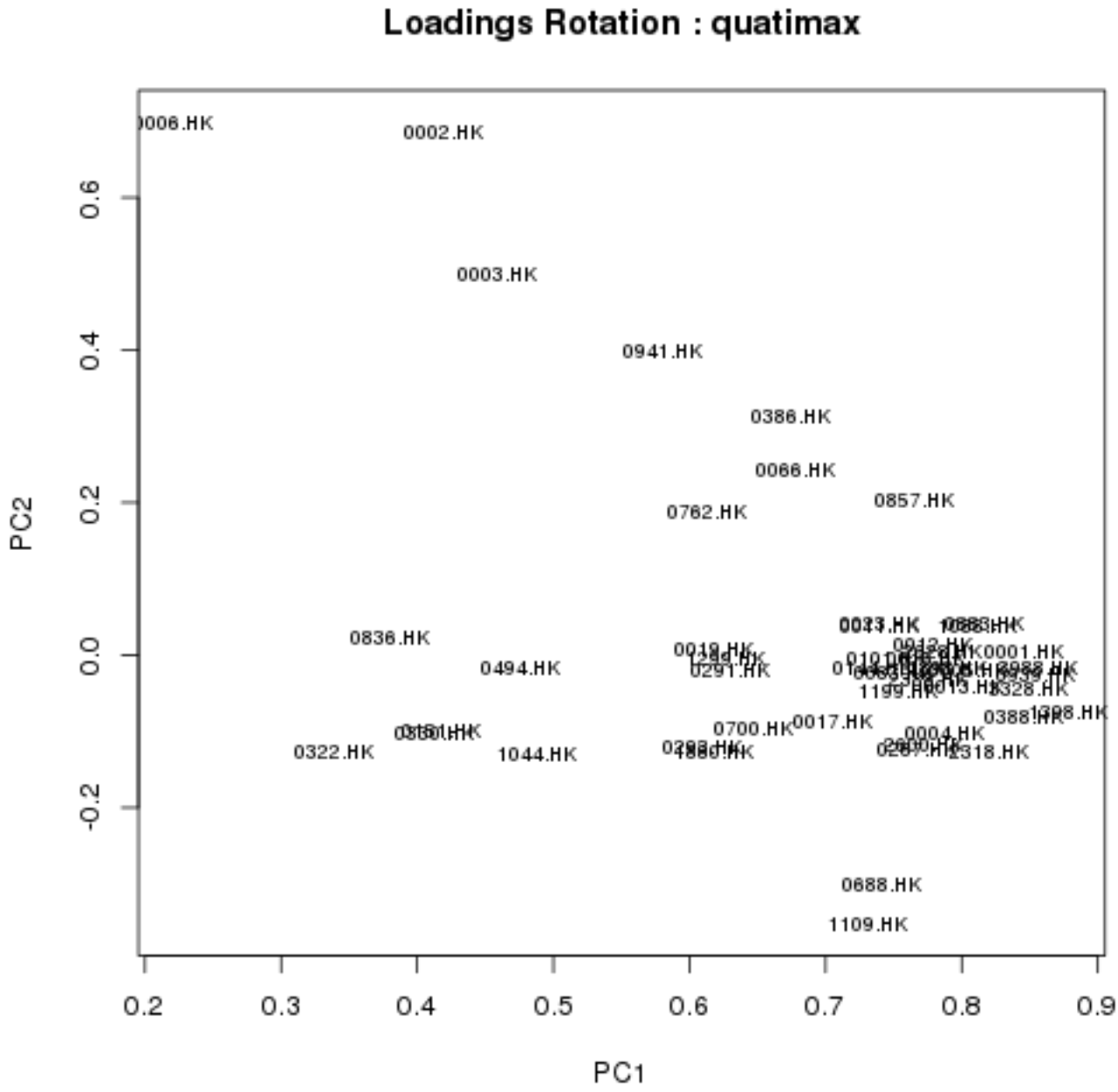
### 5.2.3 Rotation : quatimax

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 0.88 -0.07  0.09 -0.11 -0.07 0.80 0.20
## 3988.HK   48 0.86 -0.02  0.09 -0.08  0.00 0.75 0.25
## 0939.HK   33 0.86 -0.03  0.12 -0.07 -0.02 0.75 0.25
## 3328.HK   47 0.85 -0.05  0.07 -0.13  0.01 0.75 0.25
## 0001.HK    1 0.85  0.01 -0.25  0.13 -0.03 0.80 0.20
## 0388.HK   25 0.85 -0.08 -0.10  0.04 -0.06 0.74 0.26
## 2318.HK   43 0.82 -0.13  0.02 -0.13 -0.08 0.71 0.29
## 0883.HK   32 0.82  0.04  0.12 -0.15 -0.02 0.71 0.29
## 1088.HK   36 0.81  0.04  0.14 -0.07  0.05 0.69 0.31
## 0005.HK    5 0.81 -0.02 -0.01 -0.12 -0.03 0.67 0.33
## 0013.HK    9 0.80 -0.04 -0.18  0.11  0.00 0.69 0.31
## 1898.HK   42 0.79 -0.02  0.07 -0.11 -0.03 0.64 0.36
## 0004.HK    4 0.79 -0.10 -0.19  0.04 -0.04 0.67 0.33
## 2628.HK   46 0.79  0.00  0.05 -0.14 -0.05 0.64 0.36
## 0012.HK    8 0.78  0.01 -0.26  0.08  0.01 0.68 0.32
## 2388.HK   44 0.78 -0.03 -0.03  0.06 -0.17 0.64 0.36
## 0016.HK   10 0.77  0.00 -0.31  0.04 -0.08 0.70 0.30
## 2600.HK   45 0.77 -0.12  0.06 -0.14 -0.03 0.64 0.36
## 0267.HK   19 0.77 -0.13  0.05  0.08  0.07 0.62 0.38
## 0857.HK   31 0.77  0.20  0.14 -0.20  0.13 0.70 0.30
## 1199.HK   38 0.75 -0.05  0.02 -0.23  0.05 0.63 0.37
## 0083.HK   15 0.75 -0.02 -0.29  0.02  0.01 0.65 0.35
## 0101.HK   16 0.74  0.00 -0.19  0.01  0.06 0.60 0.40
## 0688.HK   27 0.74 -0.30  0.02 -0.12 -0.06 0.66 0.34
## 0011.HK    7 0.74  0.04 -0.21  0.22 -0.13 0.66 0.34
## 0023.HK   13 0.74  0.04 -0.04  0.16 -0.20 0.62 0.38
## 0144.HK   17 0.73 -0.02  0.08 -0.11  0.13 0.57 0.43
## 1109.HK   37 0.73 -0.35  0.00 -0.10  0.00 0.67 0.33
## 0017.HK   11 0.71 -0.09 -0.30  0.02  0.03 0.60 0.40
## 0066.HK   14 0.68  0.24 -0.11  0.16  0.03 0.56 0.44
## 0386.HK   24 0.68  0.31  0.17 -0.23  0.22 0.68 0.32
## 0700.HK   28 0.65 -0.10  0.17 -0.07 -0.24 0.52 0.48
## 0291.HK   20 0.63 -0.02 -0.03  0.07  0.08 0.41 0.59
## 1299.HK   39 0.63  0.00 -0.01  0.04  0.04 0.40 0.60
## 0019.HK   12 0.62  0.01 -0.09  0.31  0.01 0.49 0.51
## 1880.HK   41 0.62 -0.13  0.19 -0.03 -0.01 0.43 0.57
## 0762.HK   29 0.61  0.19  0.35 -0.12  0.04 0.55 0.45
## 0293.HK   21 0.61 -0.12 -0.10  0.16 -0.04 0.42 0.58
## 0941.HK   34 0.58  0.40  0.18 -0.03  0.07 0.53 0.47
## 1044.HK   35 0.49 -0.13  0.37  0.32 -0.16 0.52 0.48
## 0494.HK   26 0.48 -0.02  0.07 -0.14 -0.08 0.26 0.74
## 0330.HK   23 0.41 -0.10  0.03 -0.04  0.41 0.35 0.65
## 0006.HK    6 0.22  0.70  0.03 -0.12 -0.13 0.57 0.43
## 0002.HK    2 0.42  0.69  0.00  0.13 -0.21 0.71 0.29
## 0003.HK    3 0.46  0.50 -0.13  0.26  0.11 0.56 0.44
## 0151.HK   18 0.42 -0.10  0.46  0.42  0.11 0.59 0.41
## 0322.HK   22 0.34 -0.13  0.37  0.56 -0.02 0.59 0.41
## 0836.HK   30 0.38  0.02 -0.10  0.17  0.71 0.69 0.31
```

```
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    23.49 2.00 1.47 1.38 1.07
## Proportion Var  0.49 0.04 0.03 0.03 0.02
## Cumulative Var  0.49 0.53 0.56 0.59 0.61
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  38.58 0.3
## The degrees of freedom for the model are 898  and the objective function was  5.5
##  0.3The number of observations was  377  with Chi Square =  1956  with prob <  1.7e-80
##  0.3
## Fit based upon off diagonal values = 0.99
##            PC1       PC2
## 0001.HK 0.8460  0.005485
## 0002.HK 0.4192  0.685698
## 0003.HK 0.4586  0.499516
## 0004.HK 0.7881 -0.101910
## 0005.HK 0.8052 -0.021149
## 0006.HK 0.2215  0.698521
## 0011.HK 0.7398  0.037135
## 0012.HK 0.7796  0.014755
## 0013.HK 0.8017 -0.040207
## 0016.HK 0.7736 -0.003052
## 0017.HK 0.7060 -0.085865
## 0019.HK 0.6185  0.008588
## 0023.HK 0.7394  0.042575
## 0066.HK 0.6784  0.242322
## 0083.HK 0.7493 -0.021713
## 0101.HK 0.7448 -0.003324
## 0144.HK 0.7341 -0.018297
## 0151.HK 0.4183 -0.100718
## 0267.HK 0.7669 -0.125068
## 0291.HK 0.6298 -0.018989
## 0293.HK 0.6088 -0.119596
## 0322.HK 0.3382 -0.126510
## 0330.HK 0.4123 -0.101396
## 0386.HK 0.6753  0.312666
## 0388.HK 0.8454 -0.081087
## 0494.HK 0.4761 -0.017085
## 0688.HK 0.7421 -0.301657
## 0700.HK 0.6474 -0.095591
## 0762.HK 0.6128  0.187398
## 0836.HK 0.3792  0.021485
## 0857.HK 0.7651  0.202313
## 0883.HK 0.8168  0.040469
## 0939.HK 0.8551 -0.025183
## 0941.HK 0.5798  0.400089
## 1044.HK 0.4881 -0.129797
## 1088.HK 0.8121  0.036813
## 1109.HK 0.7311 -0.352130
## 1199.HK 0.7541 -0.046636
## 1299.HK 0.6261 -0.003726
## 1398.HK 0.8790 -0.074956
## 1880.HK 0.6180 -0.126445
## 1898.HK 0.7886 -0.016658
## 2318.HK 0.8200 -0.125319
```

```
## 2388.HK 0.7757 -0.032641
## 2600.HK 0.7721 -0.116199
## 2628.HK 0.7858  0.004311
## 3328.HK 0.8496 -0.045245
## 3988.HK 0.8555 -0.018079
```



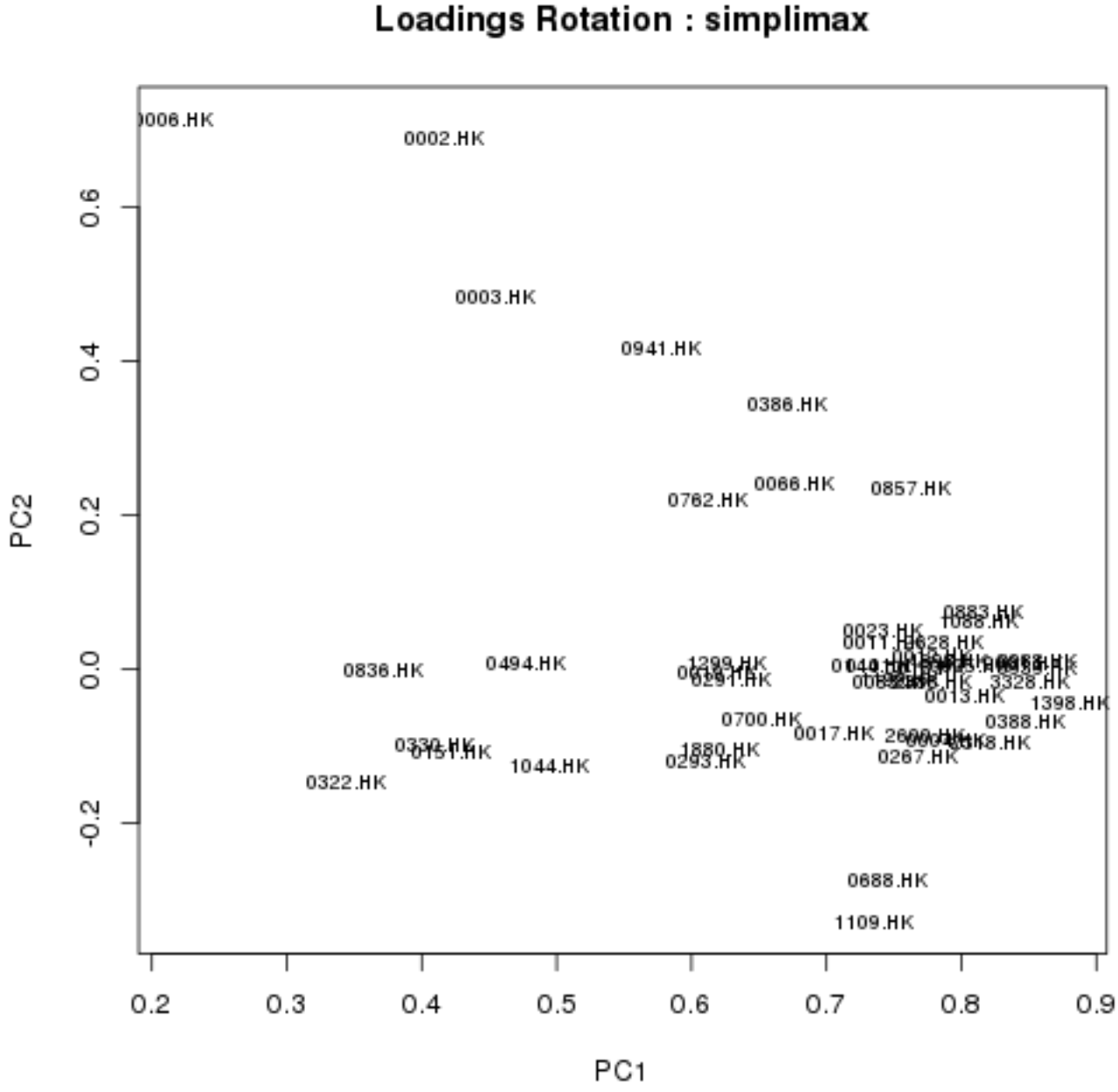
### 5.2.4 Rotation : simplimax

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 0.88 -0.04  0.08  0.17 -0.05 0.80 0.20
## 3988.HK   48 0.86  0.01  0.08  0.13  0.01 0.75 0.25
## 0939.HK   33 0.86  0.00  0.11  0.12  0.00 0.75 0.25
## 3328.HK   47 0.85 -0.02  0.05  0.17  0.03 0.75 0.25
## 0388.HK   25 0.85 -0.07 -0.10  0.01 -0.06 0.74 0.26
## 0001.HK    1 0.85  0.01 -0.25 -0.09 -0.04 0.80 0.20
## 2318.HK   43 0.82 -0.10  0.02  0.19 -0.07 0.71 0.29
## 0883.HK   32 0.82  0.07  0.10  0.20  0.01 0.71 0.29
## 1088.HK   36 0.81  0.06  0.13  0.10  0.07 0.69 0.31
## 0005.HK    5 0.81  0.01 -0.02  0.17 -0.02 0.67 0.33
## 0013.HK    9 0.80 -0.04 -0.18 -0.07 -0.01 0.69 0.31
## 1898.HK   42 0.79  0.01  0.06  0.15 -0.02 0.64 0.36
## 0004.HK    4 0.79 -0.09 -0.18  0.00 -0.04 0.67 0.33
## 2628.HK   46 0.79  0.03  0.04  0.19 -0.03 0.64 0.36
## 0012.HK    8 0.78  0.02 -0.26 -0.05  0.00 0.68 0.32
## 2388.HK   44 0.78 -0.02 -0.03  0.00 -0.16 0.64 0.36
## 0016.HK   10 0.77  0.00 -0.31  0.00 -0.09 0.70 0.30
## 2600.HK   45 0.77 -0.09  0.05  0.19 -0.01 0.64 0.36
## 0267.HK   19 0.77 -0.11  0.05 -0.04  0.08 0.62 0.38
## 0857.HK   31 0.76  0.23  0.11  0.21  0.16 0.70 0.30
## 1199.HK   38 0.75 -0.01  0.00  0.26  0.06 0.63 0.37
## 0083.HK   15 0.75 -0.02 -0.30  0.00  0.00 0.65 0.35
## 0688.HK   27 0.75 -0.27  0.01  0.18 -0.06 0.66 0.34
## 0101.HK   16 0.74  0.00 -0.20  0.01  0.05 0.60 0.40
## 0023.HK   13 0.74  0.05 -0.02 -0.10 -0.19 0.62 0.38
## 0011.HK    7 0.74  0.03 -0.20 -0.17 -0.14 0.66 0.34
## 1109.HK   37 0.73 -0.33 -0.01  0.15  0.00 0.67 0.33
## 0144.HK   17 0.73  0.01  0.06  0.13  0.15 0.57 0.43
## 0017.HK   11 0.71 -0.08 -0.30  0.00  0.01 0.60 0.40
## 0066.HK   14 0.68  0.24 -0.11 -0.14  0.03 0.56 0.44
## 0386.HK   24 0.67  0.34  0.13  0.22  0.25 0.68 0.32
## 0700.HK   28 0.65 -0.07  0.17  0.15 -0.22 0.52 0.48
## 0291.HK   20 0.63 -0.01 -0.04 -0.05  0.08 0.41 0.59
## 1299.HK   39 0.63  0.01 -0.01 -0.01  0.05 0.40 0.60
## 1880.HK   41 0.62 -0.10  0.18  0.08  0.01 0.43 0.57
## 0019.HK   12 0.62  0.00 -0.07 -0.29  0.00 0.49 0.51
## 0762.HK   29 0.61  0.22  0.33  0.15  0.09 0.55 0.45
## 0293.HK   21 0.61 -0.12 -0.09 -0.12 -0.04 0.42 0.58
## 0941.HK   34 0.58  0.42  0.16  0.04  0.11 0.53 0.47
## 1044.HK   35 0.49 -0.13  0.40 -0.25 -0.13 0.52 0.48
## 0494.HK   26 0.48  0.01  0.06  0.18 -0.06 0.26 0.74
## 0006.HK    6 0.22  0.71  0.02  0.13 -0.10 0.57 0.43
## 0002.HK    2 0.42  0.69  0.01 -0.10 -0.19 0.71 0.29
## 0003.HK    3 0.45  0.48 -0.13 -0.28  0.12 0.56 0.44
## 0151.HK   18 0.42 -0.11  0.48 -0.39  0.14 0.59 0.41
## 0322.HK   22 0.34 -0.15  0.41 -0.52  0.00 0.59 0.41
## 0836.HK   30 0.37  0.00 -0.13 -0.26  0.71 0.69 0.31
## 0330.HK   23 0.41 -0.10  0.01  0.00  0.41 0.35 0.65
##
```

```
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    23.48 2.00 1.47 1.38 1.08
## Proportion Var  0.49 0.04 0.03 0.03 0.02
## Cumulative Var  0.49 0.53 0.56 0.59 0.61
##
##  With component correlations of
##       PC1   PC2   PC3   PC4   PC5
## PC1  1.00 -0.01  0.00 -0.05 -0.01
## PC2 -0.01  1.00 -0.01 -0.04 -0.01
## PC3  0.00 -0.01  1.00  0.01 -0.02
## PC4 -0.05 -0.04  0.01  1.00  0.13
## PC5 -0.01 -0.01 -0.02  0.13  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  38.58 0.3
## The degrees of freedom for the model are 898  and the objective function was  5.5
##  0.3The number of observations was  377  with Chi Square =  1956  with prob <  1.7e-80
##  0.3
## Fit based upon off diagonal values = 0.99
##            PC1       PC2
## 0001.HK 0.8465  0.007212
## 0002.HK 0.4166  0.688483
## 0003.HK 0.4542  0.482820
## 0004.HK 0.7894 -0.092867
## 0005.HK 0.8060  0.005756
## 0006.HK 0.2168  0.714133
## 0011.HK 0.7415  0.033900
## 0012.HK 0.7793  0.017452
## 0013.HK 0.8025 -0.036162
## 0016.HK 0.7740  0.002339
## 0017.HK 0.7058 -0.082453
## 0019.HK 0.6200 -0.003102
## 0023.HK 0.7424  0.050288
## 0066.HK 0.6770  0.241147
## 0083.HK 0.7488 -0.016965
## 0101.HK 0.7442  0.004724
## 0144.HK 0.7336  0.005106
## 0151.HK 0.4225 -0.108088
## 0267.HK 0.7686 -0.113254
## 0291.HK 0.6300 -0.012707
## 0293.HK 0.6110 -0.119315
## 0322.HK 0.3441 -0.145979
## 0330.HK 0.4094 -0.097322
## 0386.HK 0.6710  0.343376
## 0388.HK 0.8473 -0.067582
## 0494.HK 0.4773  0.007569
## 0688.HK 0.7456 -0.274175
## 0700.HK 0.6518 -0.065303
## 0762.HK 0.6126  0.219136
## 0836.HK 0.3725 -0.001100
## 0857.HK 0.7627  0.234049
## 0883.HK 0.8173  0.073078
## 0939.HK 0.8567  0.002849
## 0941.HK 0.5770  0.418059
## 1044.HK 0.4945 -0.125442
## 1088.HK 0.8125  0.062689
```

```
## 1109.HK 0.7344 -0.327979
## 1199.HK 0.7539 -0.013955
## 1299.HK 0.6264  0.006197
## 1398.HK 0.8812 -0.043377
## 1880.HK 0.6206 -0.103740
## 1898.HK 0.7898  0.011190
## 2318.HK 0.8223 -0.095435
## 2388.HK 0.7786 -0.017393
## 2600.HK 0.7739 -0.086158
## 2628.HK 0.7867  0.034525
## 3328.HK 0.8505 -0.015425
## 3988.HK 0.8567  0.009365
```



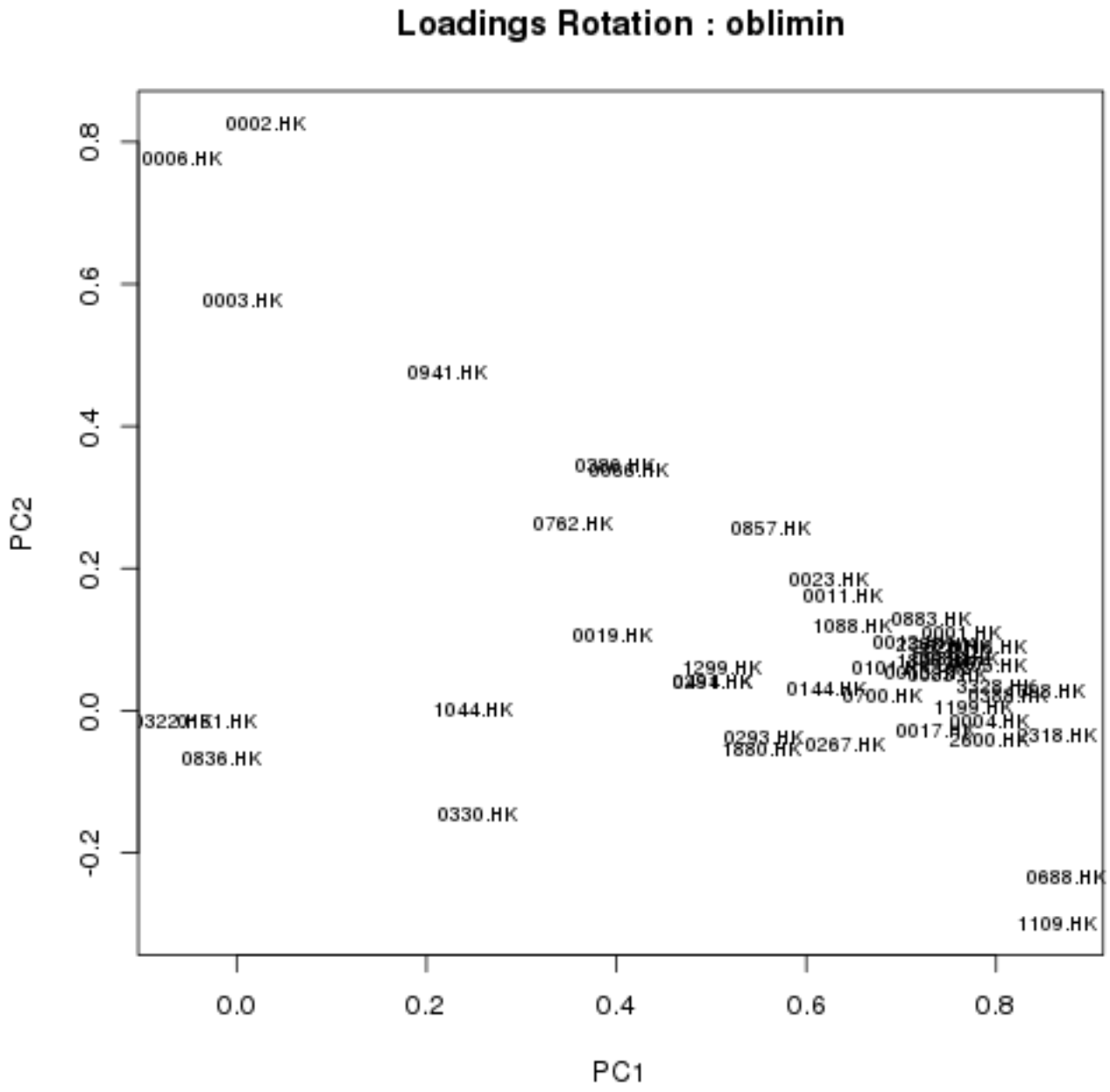
### 5.2.5 Rotation : oblimin

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   PC4   PC5   PC3   h2   u2
## 0688.HK   27  0.88 -0.23  0.03 -0.06  0.06 0.66 0.34
## 1109.HK   37  0.87 -0.30  0.03  0.00  0.04 0.67 0.33
## 2318.HK   43  0.86 -0.04  0.01 -0.06  0.08 0.71 0.29
## 1398.HK   40  0.85  0.03  0.07 -0.04  0.12 0.80 0.20
## 0388.HK   25  0.81  0.02  0.06  0.02 -0.11 0.74 0.26
## 3328.HK   47  0.80  0.04  0.03  0.04  0.14 0.75 0.25
## 2600.HK   45  0.79 -0.04  0.02 -0.01  0.13 0.64 0.36
## 0004.HK    4  0.79 -0.01  0.00  0.05 -0.17 0.67 0.33
## 0016.HK   10  0.79  0.09 -0.11  0.04 -0.26 0.70 0.30
## 0005.HK    5  0.79  0.06 -0.02  0.01  0.07 0.67 0.33
## 1199.HK   38  0.77  0.00 -0.10  0.06  0.18 0.63 0.37
## 0001.HK    1  0.76  0.11  0.01  0.10 -0.26 0.80 0.20
## 3988.HK   48  0.76  0.07  0.09  0.03  0.12 0.75 0.25
## 0939.HK   33  0.75  0.07  0.12  0.02  0.13 0.75 0.25
## 2628.HK   46  0.75  0.09  0.00 -0.02  0.13 0.64 0.36
## 0083.HK   15  0.75  0.05 -0.11  0.12 -0.21 0.65 0.35
## 0017.HK   11  0.74 -0.03 -0.11  0.13 -0.22 0.60 0.40
## 1898.HK   42  0.74  0.07  0.04  0.00  0.12 0.64 0.36
## 2388.HK   44  0.74  0.09  0.11 -0.10 -0.10 0.64 0.36
## 0883.HK   32  0.73  0.13  0.04  0.01  0.19 0.71 0.29
## 0013.HK    9  0.73  0.05  0.05  0.10 -0.19 0.69 0.31
## 0012.HK    8  0.71  0.10 -0.04  0.13 -0.22 0.68 0.32
## 0101.HK   16  0.69  0.06 -0.06  0.15 -0.12 0.60 0.40
## 0700.HK   28  0.68  0.02  0.15 -0.25  0.10 0.52 0.48
## 1088.HK   36  0.65  0.12  0.12  0.09  0.17 0.69 0.31
## 0267.HK   19  0.64 -0.05  0.19  0.13  0.01 0.62 0.38
## 0011.HK    7  0.64  0.16  0.10  0.00 -0.31 0.66 0.34
## 0023.HK   13  0.63  0.18  0.18 -0.11 -0.17 0.62 0.38
## 0144.HK   17  0.62  0.03  0.04  0.17  0.17 0.57 0.43
## 0857.HK   31  0.56  0.26 -0.01  0.17  0.29 0.70 0.30
## 0293.HK   21  0.56 -0.04  0.14  0.04 -0.18 0.42 0.58
## 1880.HK   41  0.55 -0.06  0.19 -0.01  0.15 0.43 0.57
## 1299.HK   39  0.51  0.06  0.09  0.10 -0.01 0.40 0.60
## 0494.HK   26  0.50  0.04 -0.02 -0.08  0.13 0.26 0.74
## 0291.HK   20  0.50  0.04  0.10  0.15 -0.04 0.41 0.59
## 0066.HK   14  0.41  0.34  0.09  0.15 -0.14 0.56 0.44
## 0386.HK   24  0.40  0.34 -0.04  0.25  0.36 0.68 0.32
## 0019.HK   12  0.40  0.11  0.26  0.13 -0.25 0.49 0.51
## 0002.HK    2  0.03  0.83  0.08 -0.09 -0.08 0.71 0.29
## 0006.HK    6 -0.06  0.78 -0.13 -0.07  0.13 0.57 0.43
## 0003.HK    3  0.01  0.58  0.11  0.28 -0.18 0.56 0.44
## 0941.HK   34  0.22  0.48  0.11  0.13  0.21 0.53 0.47
## 0322.HK   22 -0.07 -0.01  0.78  0.04 -0.11 0.59 0.41
## 0151.HK   18 -0.02 -0.02  0.73  0.15  0.09 0.59 0.41
## 1044.HK   35  0.25  0.00  0.60 -0.14  0.01 0.52 0.48
## 0836.HK   30 -0.02 -0.07  0.09  0.83  0.03 0.69 0.31
## 0330.HK   23  0.25 -0.15  0.04  0.44  0.16 0.35 0.65
## 0762.HK   29  0.35  0.26  0.19  0.04  0.36 0.55 0.45
```

```
##
##                  PC1  PC2  PC4  PC5  PC3
## SS loadings    20.32 3.13 2.58 1.95 1.43
## Proportion Var  0.42 0.07 0.05 0.04 0.03
## Cumulative Var  0.42 0.49 0.54 0.58 0.61
##
##  With component correlations of
##      PC1  PC2  PC4   PC5   PC3
## PC1 1.00 0.38 0.43  0.39  0.05
## PC2 0.38 1.00 0.16  0.21  0.01
## PC4 0.43 0.16 1.00  0.16  0.05
## PC5 0.39 0.21 0.16  1.00 -0.05
## PC3 0.05 0.01 0.05 -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  38.58 0.3
## The degrees of freedom for the model are 898  and the objective function was  5.5
##  0.3The number of observations was  377  with Chi Square =  1956  with prob <  1.7e-80
##  0.3
## Fit based upon off diagonal values = 0.99
##               PC1       PC2
## 0001.HK  0.764137  0.109752
## 0002.HK  0.031035  0.826520
## 0003.HK  0.006287  0.576645
## 0004.HK  0.792621 -0.014501
## 0005.HK  0.789622  0.062317
## 0006.HK -0.057285  0.776001
## 0011.HK  0.638030  0.163299
## 0012.HK  0.713539  0.097621
## 0013.HK  0.725642  0.052507
## 0016.HK  0.791922  0.090422
## 0017.HK  0.737688 -0.028185
## 0019.HK  0.395552  0.106890
## 0023.HK  0.625150  0.184604
## 0066.HK  0.414325  0.337972
## 0083.HK  0.748784  0.048944
## 0101.HK  0.690577  0.061246
## 0144.HK  0.620954  0.029273
## 0151.HK -0.020856 -0.016536
## 0267.HK  0.641025 -0.048807
## 0291.HK  0.500474  0.040234
## 0293.HK  0.555226 -0.037361
## 0322.HK -0.065999 -0.014468
## 0330.HK  0.254567 -0.146158
## 0386.HK  0.399113  0.344901
## 0388.HK  0.811798  0.021839
## 0494.HK  0.502001  0.040038
## 0688.HK  0.875084 -0.233078
## 0700.HK  0.679674  0.021780
## 0762.HK  0.353738  0.261659
## 0836.HK -0.016599 -0.067616
## 0857.HK  0.563023  0.258186
## 0883.HK  0.731523  0.127699
## 0939.HK  0.754555  0.072259
## 0941.HK  0.222338  0.477201
## 1044.HK  0.248380  0.002307
```

```
## 1088.HK  0.648808  0.119802
## 1109.HK  0.865346 -0.298910
## 1199.HK  0.774844  0.003206
## 1299.HK  0.510995  0.061554
## 1398.HK  0.852034  0.027168
## 1880.HK  0.553469 -0.055519
## 1898.HK  0.736083  0.070651
## 2318.HK  0.863545 -0.035507
## 2388.HK  0.735660  0.093178
## 2600.HK  0.793131 -0.041496
## 2628.HK  0.754306  0.091251
## 3328.HK  0.799478  0.035765
## 3988.HK  0.761242  0.074747
```



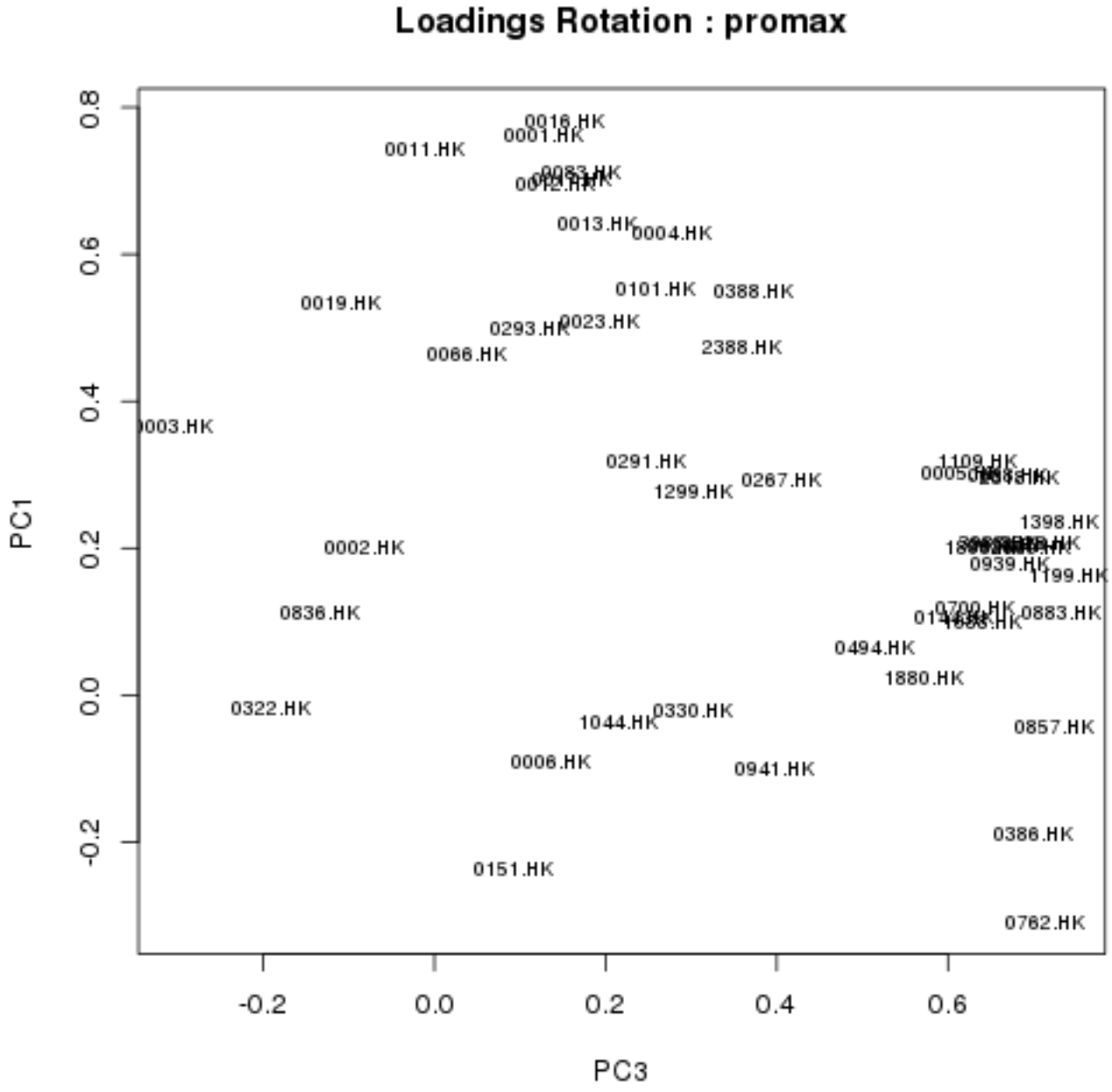
### 5.2.6 Rotation : promax

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   PC3   PC1   PC2   PC4   PC5   h2   u2
## 1199.HK   38  0.74  0.16 -0.04 -0.16  0.03 0.63 0.37
## 0883.HK   32  0.73  0.11  0.09 -0.02 -0.03 0.71 0.29
## 1398.HK   40  0.73  0.24 -0.01  0.03 -0.08 0.80 0.20
## 0857.HK   31  0.72 -0.04  0.22 -0.08  0.13 0.70 0.30
## 0762.HK   29  0.71 -0.31  0.23  0.16  0.02 0.55 0.45
## 3328.HK   47  0.71  0.21 -0.01 -0.02  0.01 0.75 0.25
## 0386.HK   24  0.70 -0.19  0.30 -0.10  0.22 0.68 0.32
## 2600.HK   45  0.70  0.20 -0.08 -0.03 -0.04 0.64 0.36
## 2318.HK   43  0.68  0.30 -0.07 -0.04 -0.09 0.71 0.29
## 0939.HK   33  0.67  0.18  0.03  0.08 -0.02 0.75 0.25
## 2628.HK   46  0.67  0.20  0.06 -0.05 -0.06 0.64 0.36
## 0688.HK   27  0.67  0.30 -0.27 -0.01 -0.07 0.66 0.34
## 3988.HK   48  0.66  0.21  0.03  0.04  0.00 0.75 0.25
## 1898.HK   42  0.64  0.20  0.04  0.00 -0.04 0.64 0.36
## 1088.HK   36  0.64  0.10  0.08  0.08  0.06 0.69 0.31
## 1109.HK   37  0.63  0.32 -0.34  0.00  0.00 0.67 0.33
## 0700.HK   28  0.63  0.12  0.01  0.12 -0.28 0.52 0.48
## 0005.HK    5  0.61  0.30  0.03 -0.08 -0.03 0.67 0.33
## 0144.HK   17  0.61  0.10 -0.02  0.00  0.15 0.57 0.43
## 1880.HK   41  0.57  0.02 -0.09  0.17 -0.02 0.43 0.57
## 0494.HK   26  0.52  0.07  0.02 -0.05 -0.10 0.26 0.74
## 0267.HK   19  0.41  0.29 -0.10  0.17  0.11 0.62 0.38
## 1299.HK   39  0.30  0.28  0.03  0.06  0.08 0.40 0.60
## 0016.HK   10  0.15  0.78  0.06 -0.15 -0.02 0.70 0.30
## 0001.HK    1  0.13  0.76  0.07 -0.02  0.04 0.80 0.20
## 0011.HK    7 -0.01  0.74  0.14  0.08 -0.07 0.66 0.34
## 0083.HK   15  0.17  0.71  0.01 -0.16  0.07 0.65 0.35
## 0017.HK   11  0.16  0.70 -0.07 -0.15  0.09 0.60 0.40
## 0012.HK    8  0.14  0.70  0.06 -0.08  0.08 0.68 0.32
## 0013.HK    9  0.19  0.64  0.01  0.01  0.06 0.69 0.31
## 0004.HK    4  0.28  0.63 -0.05 -0.04  0.01 0.67 0.33
## 0101.HK   16  0.26  0.55  0.02 -0.10  0.11 0.60 0.40
## 0388.HK   25  0.37  0.55 -0.02  0.02 -0.02 0.74 0.26
## 0019.HK   12 -0.11  0.53  0.07  0.26  0.09 0.49 0.51
## 0023.HK   13  0.19  0.51  0.17  0.16 -0.17 0.62 0.38
## 0293.HK   21  0.11  0.50 -0.07  0.13  0.01 0.42 0.58
## 2388.HK   44  0.36  0.47  0.07  0.08 -0.15 0.64 0.36
## 0066.HK   14  0.04  0.46  0.31  0.06  0.10 0.56 0.44
## 0291.HK   20  0.25  0.32  0.00  0.07  0.13 0.41 0.59
## 0002.HK    2 -0.08  0.20  0.84  0.04 -0.19 0.71 0.29
## 0006.HK    6  0.14 -0.09  0.79 -0.19 -0.15 0.57 0.43
## 0003.HK    3 -0.30  0.37  0.55  0.09  0.21 0.56 0.44
## 0941.HK   34  0.40 -0.10  0.45  0.07  0.09 0.53 0.47
## 0322.HK   22 -0.19 -0.02 -0.04  0.86  0.05 0.59 0.41
## 0151.HK   18  0.09 -0.24 -0.05  0.79  0.17 0.59 0.41
## 1044.HK   35  0.22 -0.04 -0.01  0.64 -0.15 0.52 0.48
## 0836.HK   30 -0.13  0.11 -0.15  0.09  0.86 0.69 0.31
## 0330.HK   23  0.30 -0.02 -0.21  0.02  0.46 0.35 0.65
##
```

```
##                   PC3  PC1  PC2  PC4  PC5
## SS loadings    13.33 9.85 2.62 2.16 1.45
## Proportion Var  0.28 0.21 0.05 0.05 0.03
## Cumulative Var  0.28 0.48 0.54 0.58 0.61
##
##  With component correlations of
##      PC3  PC1  PC2  PC4  PC5
## PC3 1.00 0.73 0.40 0.55 0.44
## PC1 0.73 1.00 0.34 0.54 0.39
## PC2 0.40 0.34 1.00 0.24 0.37
## PC4 0.55 0.54 0.24 1.00 0.23
## PC5 0.44 0.39 0.37 0.23 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  38.58 0.3
## The degrees of freedom for the model are 898  and the objective function was  5.5
##  0.3The number of observations was  377  with Chi Square =  1956  with prob <  1.7e-80
##  0.3
## Fit based upon off diagonal values = 0.99
##              PC3      PC1
## 0001.HK  0.12686  0.76082
## 0002.HK -0.08207  0.19990
## 0003.HK -0.30397  0.36665
## 0004.HK  0.27797  0.62960
## 0005.HK  0.61463  0.30111
## 0006.HK  0.13649 -0.08998
## 0011.HK -0.01155  0.74392
## 0012.HK  0.14208  0.69622
## 0013.HK  0.18980  0.64198
## 0016.HK  0.15382  0.78186
## 0017.HK  0.15961  0.70355
## 0019.HK -0.10971  0.53477
## 0023.HK  0.19431  0.50978
## 0066.HK  0.03881  0.46441
## 0083.HK  0.17217  0.71218
## 0101.HK  0.25892  0.55224
## 0144.HK  0.60699  0.10491
## 0151.HK  0.09270 -0.23694
## 0267.HK  0.40643  0.29320
## 0291.HK  0.24867  0.31692
## 0293.HK  0.11139  0.49783
## 0322.HK -0.18967 -0.01734
## 0330.HK  0.30111 -0.02189
## 0386.HK  0.70003 -0.18890
## 0388.HK  0.37186  0.55124
## 0494.HK  0.51519  0.06524
## 0688.HK  0.66891  0.29986
## 0700.HK  0.63187  0.11888
## 0762.HK  0.71393 -0.30877
## 0836.HK -0.13228  0.11140
## 0857.HK  0.72471 -0.04256
## 0883.HK  0.73367  0.11363
## 0939.HK  0.67355  0.17998
## 0941.HK  0.39653 -0.10110
## 1044.HK  0.21608 -0.03525
## 1088.HK  0.64035  0.09870
```

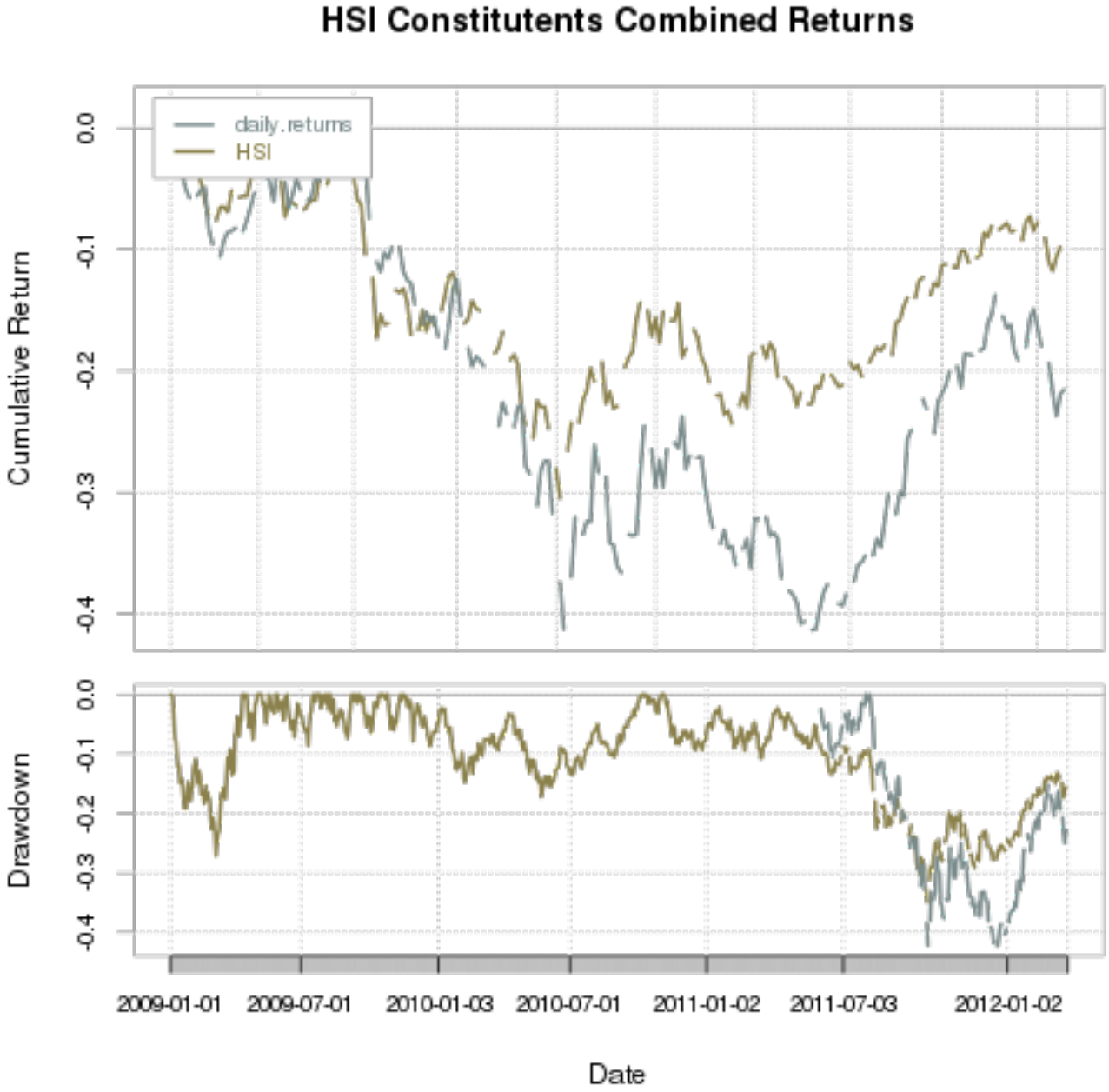
```
## 1109.HK  0.63336  0.31749
## 1199.HK  0.74194  0.16401
## 1299.HK  0.30227  0.27811
## 1398.HK  0.72960  0.23635
## 1880.HK  0.57268  0.02361
## 1898.HK  0.64200  0.20197
## 2318.HK  0.68404  0.29759
## 2388.HK  0.35867  0.47319
## 2600.HK  0.69842  0.20202
## 2628.HK  0.67090  0.20313
## 3328.HK  0.70689  0.20895
## 3988.HK  0.66039  0.20640
```



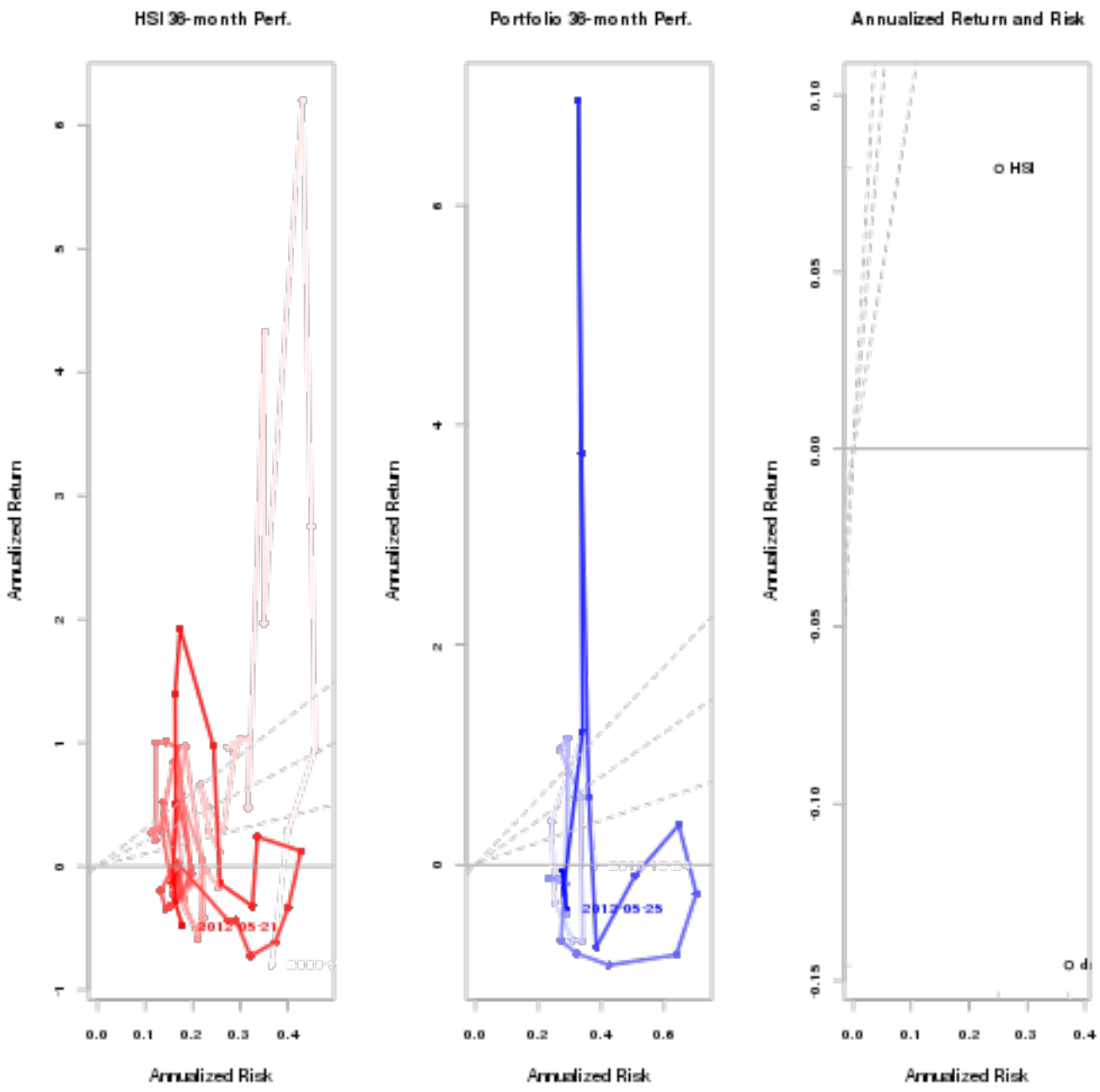
PCA is a science in itself and can not be fully covered and even less interpreted in this paper. The factors produced by principal component analysis are conceptualized as being linear combinations of the variables whereas the factors produced by common factor analysis are conceptualized as being latent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

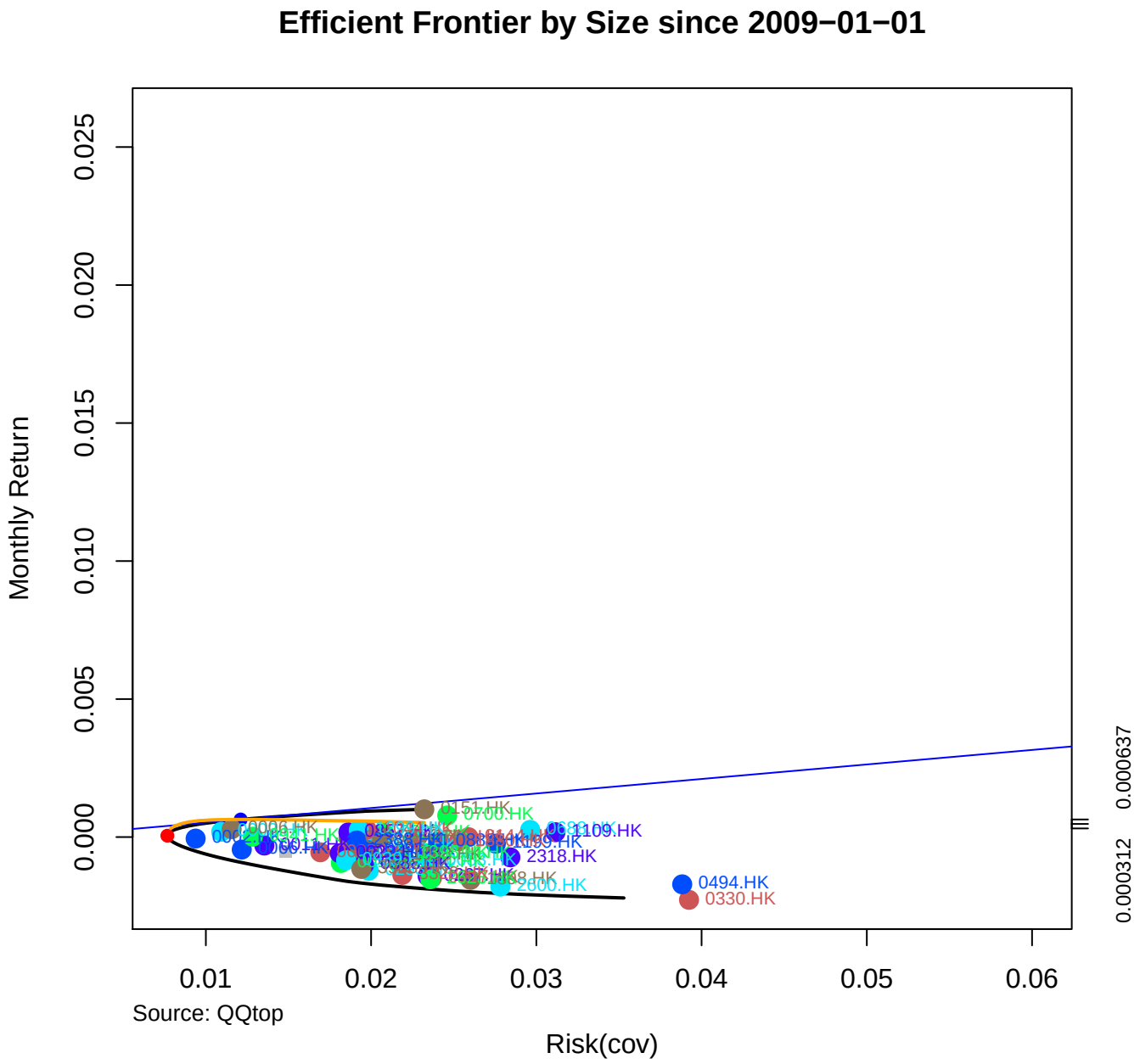
## 6.1 Performance Chart



## 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  0.0936  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
## 25  0.0000  0.4240  0.0000  0.0000  0.0000  0.0493  0.0000  0.0000  0.0000
## 37  0.0000  0.2367  0.2239  0.0000  0.0000  0.2713  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  0.1511  0.0000  0.0000  0.0126  0.0000  0.0000  0.0000  0.0000
## 25  0.0187  0.0588  0.0000  0.0000  0.1797  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  0.0621
## 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   0.0000  0.0000  0.0000  0.0000  0.8604  0.0000  0.0000  0.0000  0.0000
## 13  0.0218  0.0000  0.3060  0.0000  0.1373  0.0000  0.0000  0.0565  0.0000
## 25  0.0000  0.0000  0.1651  0.0000  0.0549  0.0000  0.0000  0.0213  0.0000
## 37  0.0000  0.0000  0.0000  0.0414  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  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 37  0.0114  0.0000  0.0518  0.0000  0.0000  0.0000  0.0387  0.0483  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  0.1396
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0746
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0038
## 37  0.0000  0.0000  0.0145  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  0.1463  0.0000  0.0000
## 25  0.0244  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  0.0190  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.2847  0.0000  0.0000  0.0000  0.0231  0.0000  0.0000  0.0000
## 37  0.0000  0.2147  0.2231  0.0000  0.0000  0.2794  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  0.1575  0.0000  0.0000  0.0055  0.0000  0.0000  0.0000  0.0000
## 25  0.0224  0.0898  0.0000  0.0000  0.1636  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  0.0801
## 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   0.0000  0.0000  0.0000  0.0000  0.9514  0.0000  0.0000  0.0000  0.0000
## 13  0.0219  0.0000  0.2726  0.0000  0.2078  0.0000  0.0000  0.0668  0.0000
## 25  0.0000  0.0000  0.2264  0.0000  0.1101  0.0000  0.0000  0.0355  0.0000
## 37  0.0000  0.0000  0.0000  0.0406  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  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
```

```
## 37  0.0138  0.0000  0.0479  0.0000  0.0000  0.0000  0.0360  0.0495  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  0.0486
## 13  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0918
## 25  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0065
## 37  0.0000  0.0000  0.0148  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  0.1571  0.0000  0.0000
## 25  0.0380  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  -0.0022 -0.0022  0.0353  0.0353  0.0860  0.0534
## 13 -0.0014 -0.0014  0.0165  0.0165  0.0388  0.0297
## 25 -0.0006 -0.0006  0.0099  0.0099  0.0236  0.0192
## 37  0.0002  0.0002  0.0079  0.0079  0.0167  0.0131
## 49  0.0010  0.0010  0.0232  0.0232  0.0477  0.0348
##
## Description:
##  Mon May 28 21:58:01 2012 by user:
```

# 7 HSI Components Ratios

## 7.1 Sharpe Ratio - Combined

```
##                                daily.returns
## StdDev Sharpe (Rf=0%, p=95%):       -0.0150
## VaR Sharpe (Rf=0%, p=95%):          -0.0098
## ES Sharpe (Rf=0%, p=95%):           -0.0077
```

### 7.2 Sharpe - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0203  0.0316  0.0417  0.0410  0.0018
## VaR Sharpe (Rf=0%, p=95%):     0.0135  0.0200  0.0252  0.0281  0.0012
## ES Sharpe (Rf=0%, p=95%):      0.0105  0.0142  0.0110  0.0221  0.0006
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0332  0.0052  0.0238  0.0396  0.0256
## VaR Sharpe (Rf=0%, p=95%):     0.0213  0.0038  0.0165  0.0274  0.0165
## ES Sharpe (Rf=0%, p=95%):      0.0149  0.0037  0.0133  0.0214  0.0112
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0123  0.0335  0.0353  0.0350  0.0243
## VaR Sharpe (Rf=0%, p=95%):     0.0081  0.0210  0.0274  0.0257  0.0161
## ES Sharpe (Rf=0%, p=95%):      0.0057  0.0124  0.0274  0.0220  0.0118
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0270  0.0307  0.0668  0.0173  0.0400
## VaR Sharpe (Rf=0%, p=95%):     0.0186  0.0207  0.0452  0.0127  0.0270
## ES Sharpe (Rf=0%, p=95%):      0.0148  0.0163  0.0343  0.0111  0.0214
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0275  0.0541 -0.0279  0.0311  0.0307
## VaR Sharpe (Rf=0%, p=95%):     0.0179  0.0457 -0.0184  0.0200  0.0219
## ES Sharpe (Rf=0%, p=95%):      0.0134  0.0457 -0.0125  0.0150  0.0181
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0223  0.0282  0.0815  0.0189  0.0049
## VaR Sharpe (Rf=0%, p=95%):     0.0189  0.0205  0.0543  0.0130  0.0031
## ES Sharpe (Rf=0%, p=95%):      0.0189  0.0174  0.0401  0.0102  0.0025
##                                0857.HK 0883.HK 0939.HK 0941.HK 1044.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0303  0.0433  0.0172  0.0065  0.0721
## VaR Sharpe (Rf=0%, p=95%):     0.0192  0.0285  0.0107  0.0043  0.0500
## ES Sharpe (Rf=0%, p=95%):      0.0145  0.0214  0.0075  0.0033  0.0387
##                                1088.HK 1109.HK 1199.HK 1299.HK 1398.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0348  0.0276  0.0199  0.0186  0.0147
## VaR Sharpe (Rf=0%, p=95%):     0.0221  0.0203  0.0137  0.0117  0.0104
## ES Sharpe (Rf=0%, p=95%):      0.0169  0.0174  0.0109  0.0069  0.0087
##                                1880.HK 1898.HK 2318.HK 2388.HK 2600.HK
## StdDev Sharpe (Rf=0%, p=95%):  0.0688  0.0181  0.0291  0.0602  0.0018
## VaR Sharpe (Rf=0%, p=95%):     0.0493  0.0111  0.0194  0.0437  0.0012
## ES Sharpe (Rf=0%, p=95%):      0.0391  0.0075  0.0140  0.0356  0.0010
##                                2628.HK 3328.HK 3988.HK
## StdDev Sharpe (Rf=0%, p=95%): -0.0058  0.0024  0.0260
## VaR Sharpe (Rf=0%, p=95%):    -0.0036  0.0015  0.0172
## ES Sharpe (Rf=0%, p=95%):     -0.0025  0.0011  0.0125
```

### 7.3 Information Ratio - Combined

```
## [1] "Information Ratio :  -0.0581"
```

### 7.4 Information Ratio - Distinct

```
##                        0001.HK 0002.HK 0003.HK 0004.HK 0005.HK 0006.HK
## Information Ratio: HSI  -0.062  -0.062    0.17  0.2606 -0.2954  0.0064
##                        0011.HK 0012.HK 0013.HK 0016.HK 0017.HK 0019.HK
## Information Ratio: HSI -0.2648 -0.0096  0.2196  0.0115 -0.1695  0.1229
```

```
##                         0023.HK 0066.HK 0083.HK 0101.HK 0144.HK 0151.HK
## Information Ratio: HSI  0.1548  0.0811 -0.0011  0.0397  0.0943  0.6711
##                         0267.HK 0291.HK 0293.HK 0322.HK 0330.HK 0386.HK
## Information Ratio: HSI -0.1018  0.2293  0.0421  0.4485 -0.6747  0.0892
##                         0388.HK 0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Information Ratio: HSI   0.088   -0.08  0.0587   1.006 -0.0718 -0.2564
##                         0857.HK 0883.HK 0939.HK 0941.HK 1044.HK 1088.HK
## Information Ratio: HSI  0.0781  0.2887 -0.1014 -0.2361  0.7917   0.157
##                         1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK
## Information Ratio: HSI  0.0436 -0.0723  0.5108 -0.1343  0.7983  -0.097
##                         2318.HK 2388.HK 2600.HK 2628.HK 3328.HK 3988.HK
## Information Ratio: HSI  0.0692  0.5597 -0.3217 -0.3822 -0.2989  0.0197
```

# 8 HSI Components Table Latest Quotes

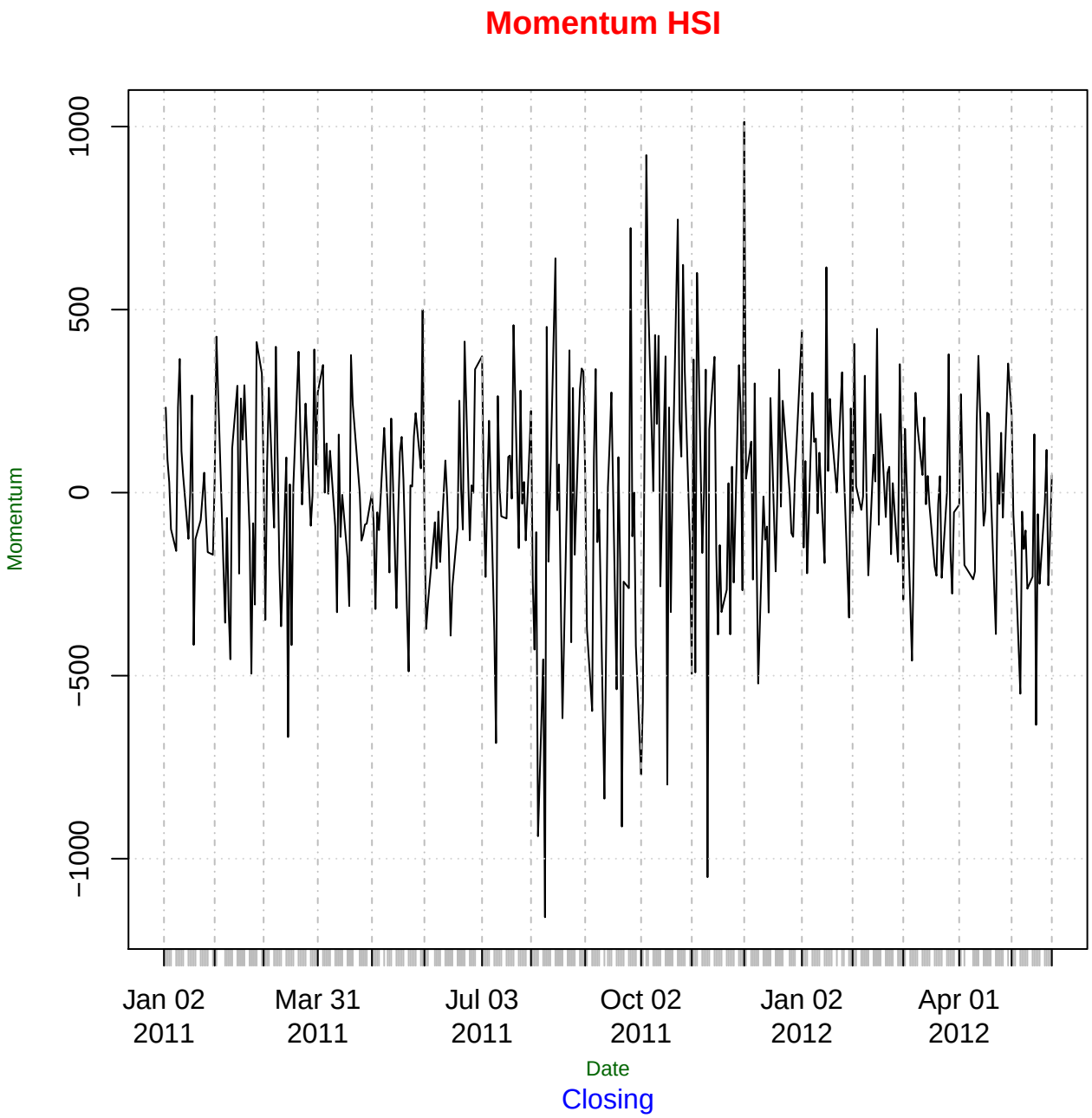
```
## [1] "Date :  2012-05-28 03:59:00"
##                    Name    Bid    Ask Change   52-week Range
## 0001.HK     CHEUNG KONG  92.50  92.55   1.00  79.10 - 123.00
## 0002.HK    CLP HOLDINGS  63.65  63.80  -0.10   62.10 - 75.20
## 0003.HK  HK & CHINA GAS  18.28  18.32   0.00   16.68 - 20.65
## 0004.HK  WHARF HOLDINGS  41.20  41.30   1.15   33.15 - 59.00
## 0005.HK   HSBC HOLDINGS  62.75  62.80   0.10   56.00 - 85.00
## 0006.HK    POWER ASSETS  54.50  54.65  -0.65   52.00 - 64.80
## 0011.HK  HANG SENG BANK 101.10 101.20  -0.20  84.40 - 125.00
## 0012.HK  HENDERSON LAND  39.15  39.20   0.75   33.20 - 53.50
## 0013.HK       HUTCHISON  66.85  66.90   0.40   53.60 - 93.10
## 0016.HK         SHK PPT  88.20  88.25   0.45  85.45 - 122.40
## 0017.HK   NEW WORLD DEV   8.22   8.25   0.13    6.13 - 13.78
## 0019.HK SWIRE PACIFIC A  84.80  84.85   2.00  75.10 - 120.90
## 0023.HK  BANK OF E ASIA  26.00  26.05  -0.25   21.85 - 34.45
## 0066.HK MTR CORPORATION  25.15  25.20  -0.10   22.45 - 28.80
## 0083.HK       SINO LAND  10.84  10.88   0.18    9.28 - 14.16
## 0101.HK   HANG LUNG PPT  24.85  24.90  -0.15   20.85 - 35.30
## 0144.HK  CHINA MER HOLD  22.75  22.80  -0.10   19.00 - 36.25
## 0151.HK WANT WANT CHINA   9.11   9.14  -0.09     6.03 - 9.58
## 0267.HK   CITIC PACIFIC  11.44  11.46   0.32   10.26 - 23.40
## 0291.HK CHINA RESOURCES  24.65  24.75   0.30   24.00 - 35.50
## 0293.HK  CATHAY PAC AIR  12.02  12.04  -0.06   11.80 - 20.15
## 0322.HK          TINGYI  19.16  19.18  -0.28   17.84 - 26.00
## 0330.HK ESPRIT HOLDINGS  12.44  12.52   0.24    7.55 - 33.30
## 0386.HK    SINOPEC CORP   7.09   7.10  -0.01     6.22 - 9.67
## 0388.HK            HKEX 109.40 109.50  -0.80  99.15 - 178.90
## 0494.HK       LI & FUNG  14.96  14.98  -0.02   10.82 - 20.15
## 0688.HK  CHINA OVERSEAS  16.38  16.40   0.64    9.99 - 17.86
## 0700.HK         TENCENT 213.20 213.60  -3.40 139.80 - 241.00
## 0762.HK    CHINA UNICOM  11.08  11.10  -0.06   12.60 - 17.68
## 0836.HK CHINA RES POWER  13.70  13.72   0.12   10.82 - 16.20
## 0857.HK      PETROCHINA  10.18  10.20   0.02    8.59 - 11.92
## 0883.HK           CNOOC  14.46  14.52   0.06   11.20 - 19.70
## 0939.HK             CCB   5.21   5.22   0.06     4.41 - 7.48
## 0941.HK    CHINA MOBILE  79.65  79.75   0.10   68.05 - 87.60
## 1044.HK    HENGAN INT'L  76.90  77.10  -0.25   56.80 - 83.45
## 1088.HK   CHINA SHENHUA  27.85  27.90   0.35   27.10 - 40.20
## 1109.HK  CHINA RES LAND  14.12  14.14   0.46    7.28 - 15.60
## 1199.HK   COSCO PACIFIC   9.19   9.21   0.10    7.52 - 16.50
## 1299.HK             AIA  24.60  24.70  -0.05   19.84 - 29.90
## 1398.HK            ICBC   4.66   4.67   0.05     3.46 - 6.68
## 1880.HK     BELLE INT'L  13.00  13.02   0.20   11.38 - 17.54
## 1898.HK      CHINA COAL   7.22   7.23   0.10    6.59 - 11.66
## 2318.HK         PING AN  56.70  56.75   0.25   37.35 - 85.45
## 2388.HK   BOC HONG KONG  22.05  22.10   0.45   14.24 - 24.65
## 2600.HK          CHALCO   3.21   3.22   0.03     3.20 - 7.35
## 2628.HK      CHINA LIFE  18.18  18.20   0.14   17.04 - 28.10
## 3328.HK        BANKCOMM   5.04   5.05   0.05     4.15 - 8.36
## 3988.HK   BANK OF CHINA   2.93   2.94   0.07     2.20 - 4.36
```

# 9 Hang Seng Index

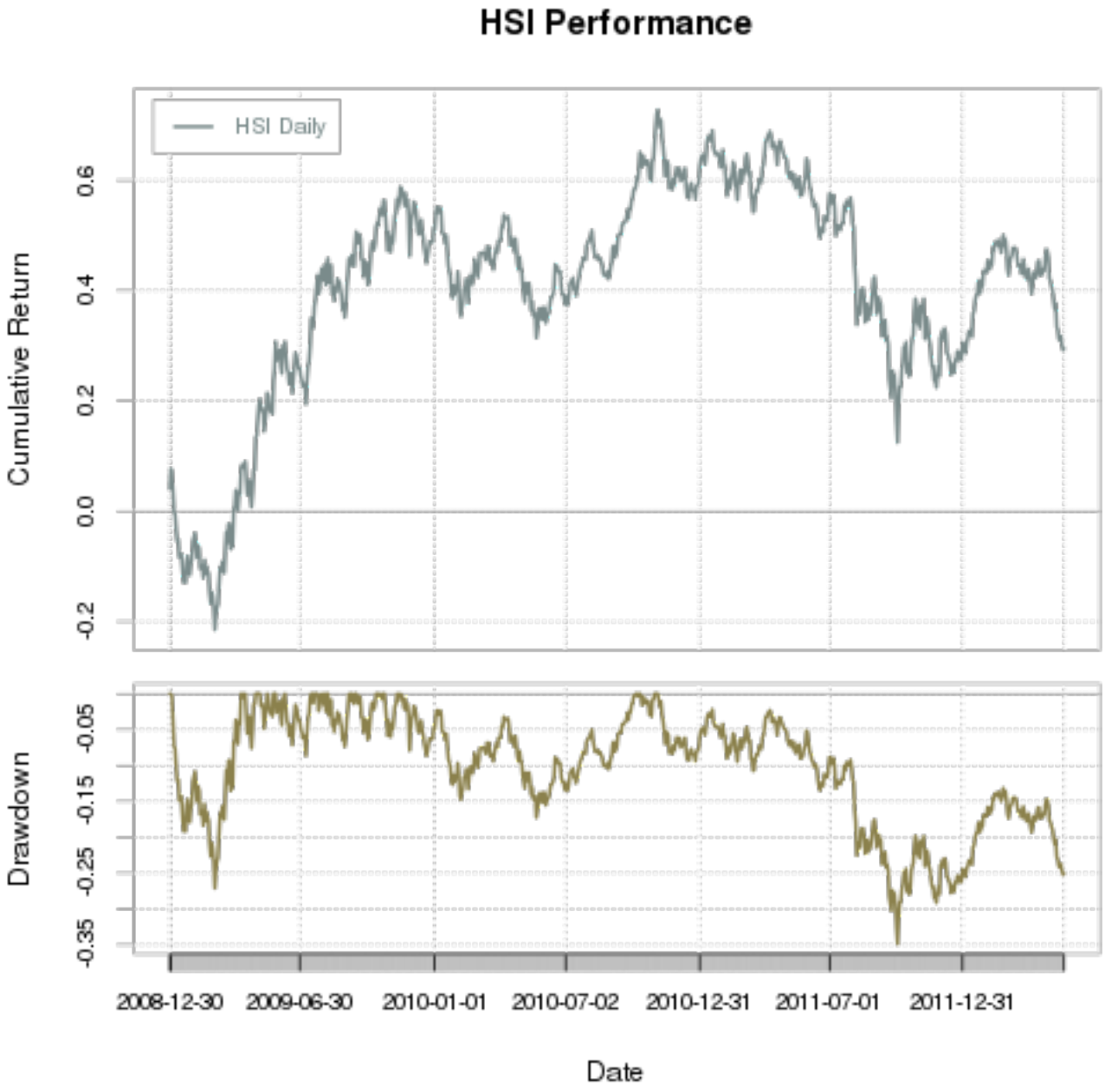
**Latest Hang Seng Index**

| | Trade Time | Name | Last | Change | Days Range | 52−week Range |
|---|---|---|---|---|---|---|
| ^HSI | 2012−05−28 04:01:00 | HANG SENG INDEX | 18801 | 87.58 | 18672.32 − 18858.32 | 16170.30 − 23924.50 |

## 9.1 Hang Seng Index - Momentum

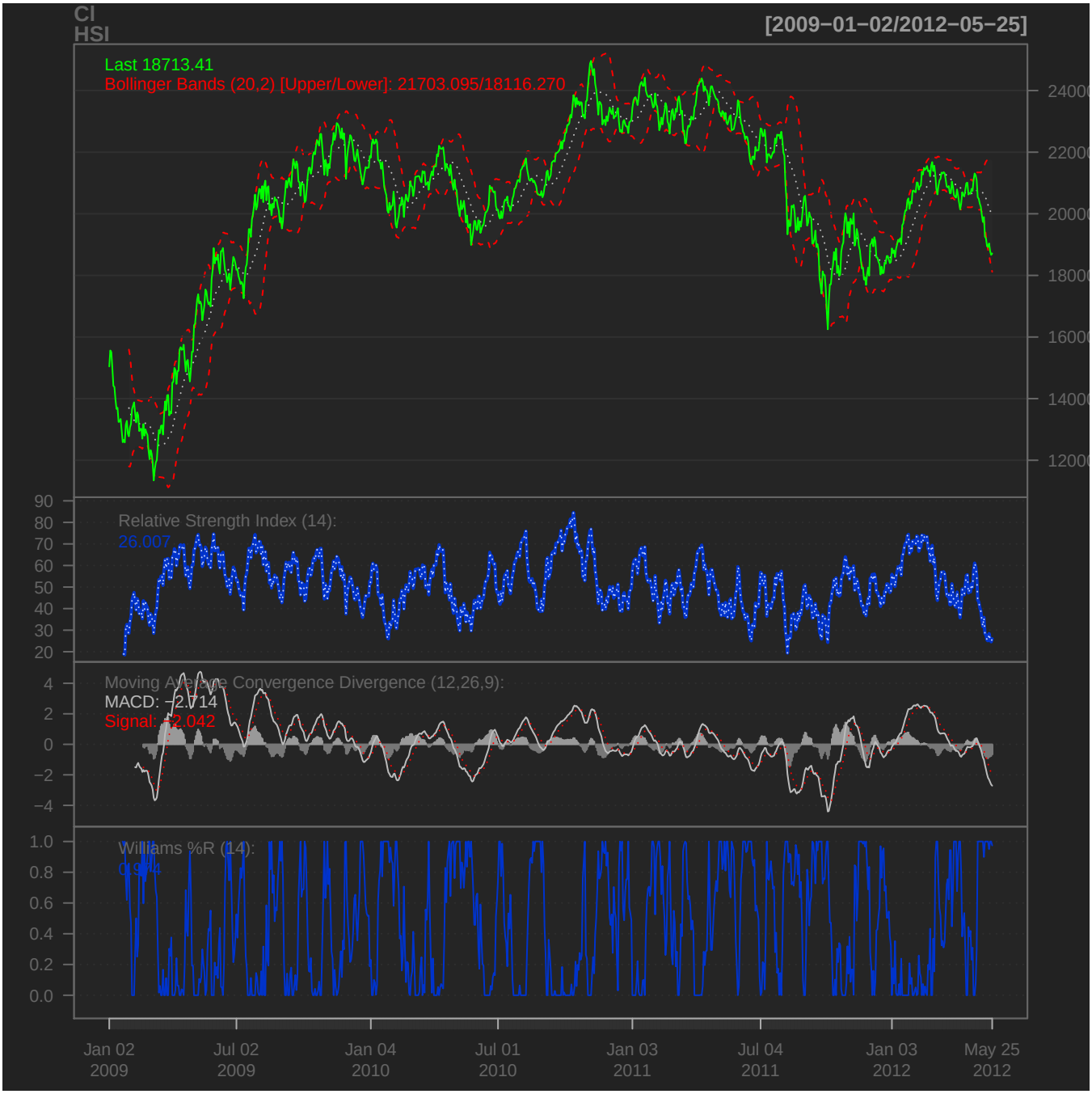


## 9.2 HSI Performance

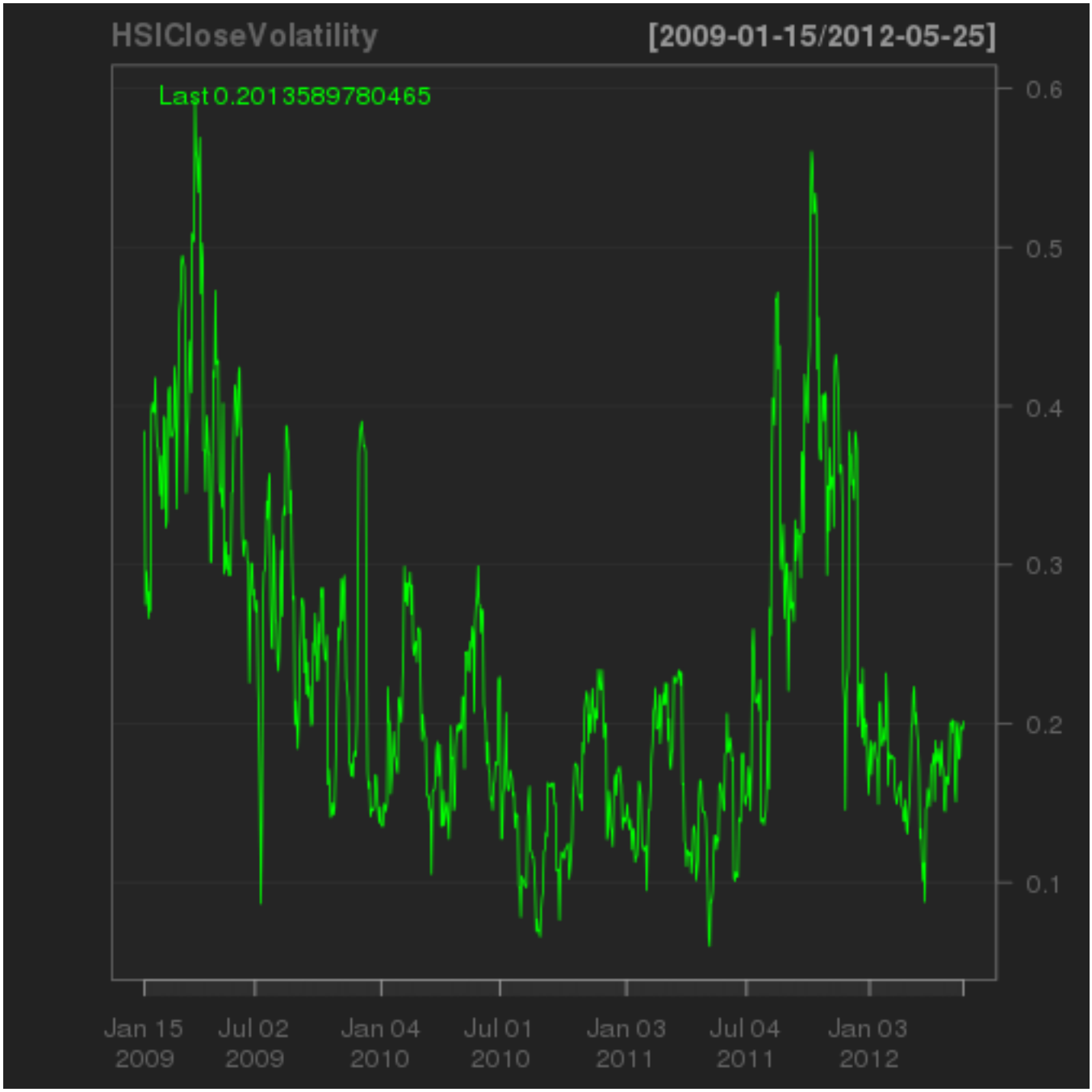


### 9.3 HSI Ratios

```
##              RSI
## 2012-05-13 31.67
## 2012-05-14 35.92
## 2012-05-15 28.35
## 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
##              macd  signal
## 2012-05-13 -0.857 -0.2854
## 2012-05-14 -1.004 -0.4291
## 2012-05-15 -1.358 -0.6150
## 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
## [1] "BBands"
##                dn  mavg    up    pctB
## 2012-05-13 19885 20674 21462 -0.0953
## 2012-05-14 19779 20638 21497  0.0669
## 2012-05-15 19525 20573 21621 -0.1262
## 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
##              WPR %
## 2012-05-13 100.00
## 2012-05-14  89.88
## 2012-05-15 100.00
## 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
```


CI
HSI
[2009−01−02/2012−05−25]
Last 18713.41
Bollinger Bands (20,2) [Upper/Lower]: 21703.095/18116.270
Relative Strength Index (14):
26.007
Moving Average Convergence Divergence (12,26,9):
MACD: −2.714
Signal: −2.042
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 25 2012

## 9.4 HSI Volatility



## 9.5 HSI Statistics

```
##                                HSI-Daily HSI-Monthly
## StdDev Sharpe (Rf=0%, p=95%):   0.02700     0.10980
## VaR Sharpe (Rf=0%, p=95%):      0.01742     0.07374
## ES Sharpe (Rf=0%, p=95%):       0.01285     0.05888
##          HSI-Daily HSI-Monthly
## Skewness    0.1277     0.09191
##          HSI-Daily HSI-Monthly
## Kurtosis     1.509     -0.2018
```

```
##      Index              HSI Daily
##  Min.   :2008-12-31   Min.   :-5.66e-02
##  1st Qu.:2009-11-03   1st Qu.:-8.11e-03
##  Median :2010-09-08   Median : 3.49e-05
##  Mean   :2010-09-10   Mean   : 4.28e-04
##  3rd Qu.:2011-07-16   3rd Qu.: 9.93e-03
##  Max.   :2012-05-23   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   : 0.00776
##  3rd Qu.:2011-07-27   3rd Qu.: 0.03806
##  Max.   :2012-05-23   Max.   : 0.17074
```

# 10 Dataset First and Last Rows Info

```
##            X0001.HK.Close
## 2009-01-02          76.90
## 2012-05-25          91.45
##            X0002.HK.Close
## 2009-01-02           52.4
## 2012-05-25           63.7
##            X0003.HK.Close
## 2009-01-02          12.08
## 2012-05-25          18.32
##            X0004.HK.Close
## 2009-01-02          22.00
## 2012-05-25          40.25
##            X0005.HK.Close
## 2009-01-02           77.0
## 2012-05-25           62.7
##            X0006.HK.Close
## 2009-01-02          42.75
## 2012-05-25          55.25
##            X0011.HK.Close
## 2009-01-02          104.7
## 2012-05-25          101.5
##            X0012.HK.Close
## 2009-01-02          30.35
## 2012-05-25          38.50
##            X0013.HK.Close
## 2009-01-02          39.85
## 2012-05-25          66.55
##            X0016.HK.Close
## 2009-01-02          67.30
## 2012-05-25          87.75
##            X0017.HK.Close
## 2009-01-02           8.18
## 2012-05-25           8.07
##            X0019.HK.Close
## 2009-01-02          55.75
## 2012-05-25          82.90
##            X0023.HK.Close
## 2009-01-02          16.68
## 2012-05-25          26.20
##            X0066.HK.Close
## 2009-01-02          18.08
## 2012-05-25          25.15
##            X0083.HK.Close
## 2009-01-02           8.36
## 2012-05-25          10.70
##            X0101.HK.Close
## 2009-01-02          18.36
## 2012-05-25          25.00
##            X0144.HK.Close
## 2009-01-02           15.4
## 2012-05-25           22.9
##            X0151.HK.Close
## 2009-01-02           3.17
## 2012-05-25           9.15
##            X0267.HK.Close
```

```
## 2009-01-02          10.20
## 2012-05-25          11.16
##            X0291.HK.Close
## 2009-01-02          14.00
## 2012-05-25          24.45
##            X0293.HK.Close
## 2009-01-02           8.91
## 2012-05-25          12.10
##            X0322.HK.Close
## 2009-01-02           8.98
## 2012-05-25          19.46
##            X0330.HK.Close
## 2009-01-02          44.80
## 2012-05-25          12.24
##            X0386.HK.Close
## 2009-01-02           4.96
## 2012-05-25           7.11
##            X0388.HK.Close
## 2009-01-02           76.6
## 2012-05-25          110.4
##            X0494.HK.Close
## 2009-01-02          14.04
## 2012-05-25          15.06
##            X0688.HK.Close
## 2009-01-02          11.22
## 2012-05-25          15.74
##            X0700.HK.Close
## 2009-01-01           50.0
## 2012-05-25          216.8
##            X0762.HK.Close
## 2009-01-01           9.63
## 2012-05-25          11.16
##            X0836.HK.Close
## 2009-01-02          15.12
## 2012-05-25          13.64
##            X0857.HK.Close
## 2009-01-02           7.20
## 2012-05-25          10.18
##            X0883.HK.Close
## 2009-01-02           7.59
## 2012-05-25          14.44
##            X0939.HK.Close
## 2009-01-02           4.52
## 2012-05-25           5.10
##            X0941.HK.Close
## 2009-01-02           81.2
## 2012-05-25           79.6
##            X1044.HK.Close
## 2009-01-01          24.90
## 2012-05-25          77.35
##            X1088.HK.Close
## 2009-01-02          17.40
## 2012-05-25          27.55
##            X1109.HK.Close
## 2009-01-02           9.90
## 2012-05-25          13.64
##            X1199.HK.Close
```

```
## 2009-01-02           8.07
## 2012-05-25           9.12
##            X1299.HK.Close
## 2010-10-29           23.1
## 2012-05-25           24.7
##            X1398.HK.Close
## 2009-01-02           4.30
## 2012-05-25           4.62
##            X1880.HK.Close
## 2009-01-02            3.5
## 2012-05-25           12.8
##            X1898.HK.Close
## 2009-01-02           6.55
## 2012-05-25           7.13
##            X2318.HK.Close
## 2009-01-02           39.6
## 2012-05-25           56.5
##            X2388.HK.Close
## 2009-01-02           9.06
## 2012-05-25          21.75
##            X2600.HK.Close
## 2009-01-02           4.55
## 2012-05-25           3.17
##            X2628.HK.Close
## 2009-01-02          24.75
## 2012-05-25          18.06
##            X3328.HK.Close
## 2009-01-02           5.91
## 2012-05-25           5.00
##            X3988.HK.Close
## 2009-01-02           2.17
## 2012-05-25           2.85
```

# 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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This is the End !