CAPM and other Statistics for HSI Components Version 1.1

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Contents

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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

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

##                      HSI Components to HSI      NA     NA     NA      NA
## Alpha                                0.0000  0.0002 0.0004 0.0006 -0.0005
## Beta                                 0.9887  0.1470 0.3776 1.1118  1.1205
## Beta+                                0.9551  0.0428 0.2765 1.1132  1.2116
## Beta-                                0.9691  0.1876 0.4105 1.0884  1.3108
## R-squared                            0.6386  0.0791 0.1786 0.4942  0.5602
## Annualized Alpha                    -0.0005  0.0506 0.1085 0.1674 -0.1237
## Correlation                          0.7991  0.2812 0.4226 0.7030  0.7485
## Correlation p-value                  0.0000  0.0000 0.0000 0.0000  0.0000
## Tracking Error                       0.1933  0.2572 0.2654 0.2938  0.2599
## Active Premium                      -0.0224 -0.0652 0.0140 0.1467 -0.1643
## Information Ratio                   -0.1157 -0.2535 0.0528 0.4995 -0.6320
## Treynor Ratio                        0.1092  0.4435 0.3824 0.2492 -0.0302
##                           NA      NA      NA     NA     NA      NA     NA
## Alpha                 0.0003 -0.0003  0.0001 0.0005 0.0002 -0.0002 0.0003
## Beta                  0.1142  0.6389  1.0189 0.9476 1.0040  1.1363 0.7846
## Beta+                 0.0599  0.7033  1.0488 0.8642 0.9684  1.0594 0.8523
## Beta-                 0.1265  0.6732  0.9918 0.9871 0.9792  1.1640 0.7225
## R-squared             0.0280  0.4525  0.5563 0.5266 0.6420  0.5026 0.3840
## Annualized Alpha      0.0885 -0.0751  0.0203 0.1322 0.0586 -0.0501 0.0766
## Correlation           0.1673  0.6727  0.7459 0.7257 0.8012  0.7089 0.6197
## Correlation p-value   0.0000  0.0000  0.0000 0.0000 0.0000  0.0000 0.0000
## Tracking Error        0.2892  0.2053  0.2365 0.2339 0.1949  0.2959 0.2643
## Active Premium       -0.0396 -0.1389 -0.0066 0.1094 0.0444 -0.0900 0.0223
## Information Ratio    -0.1369 -0.6763 -0.0279 0.4678 0.2280 -0.3043 0.0843
## Treynor Ratio         0.7947 -0.0133  0.1215 0.2530 0.1741  0.0355 0.1945
##                           NA     NA     NA     NA     NA     NA     NA
## Alpha                 0.0005 0.0003 0.0002 0.0002 0.0004 0.0011 0.0003
## Beta                  0.9397 0.5092 1.1656 1.0924 1.3103 0.4311 1.0805
## Beta+                 1.0194 0.4303 1.1350 1.2457 1.2566 0.2039 1.0318
## Beta-                 0.9269 0.5028 1.2061 0.9902 1.2203 0.5133 0.9838
## R-squared             0.4624 0.3377 0.5152 0.4635 0.5371 0.0965 0.4034
## Annualized Alpha      0.1249 0.0739 0.0492 0.0545 0.1133 0.3051 0.0749
## Correlation           0.6800 0.5811 0.7178 0.6808 0.7329 0.3106 0.6351
## Correlation p-value   0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000
## Tracking Error        0.2638 0.2250 0.2970 0.3064 0.3263 0.3735 0.3422
## Active Premium        0.0919 0.0029 0.0216 0.0171 0.0970 0.1782 0.0251
## Information Ratio     0.3484 0.0130 0.0727 0.0557 0.2973 0.4772 0.0732
## Treynor Ratio         0.2365 0.2618 0.1304 0.1350 0.1735 0.7157 0.1438
##                           NA     NA     NA      NA     NA     NA      NA
## Alpha                 0.0006 0.0005 0.0012 -0.0015 0.0004 0.0004  0.0005
```

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

```
## Beta                0.8783 0.7658 0.3479  0.9372 0.9548 1.1593  0.9712
## Beta+               0.7771 0.7316 0.2640  0.7359 0.8076 1.2461  0.9501
## Beta-               0.9059 0.7546 0.3856  1.1415 0.9919 1.1114  0.8687
## R-squared           0.3689 0.3175 0.0712  0.2130 0.5569 0.7042  0.2039
## Annualized Alpha    0.1698 0.1412 0.3537 -0.3136 0.1194 0.0952  0.1319
## Correlation         0.6074 0.5635 0.2669  0.4616 0.7463 0.8392  0.4515
## Correlation p-value 0.0000 0.0000 0.0000  0.0000 0.0000 0.0000  0.0000
## Tracking Error      0.3002 0.2981 0.3678  0.4684 0.2216 0.1996  0.5008
## Active Premium      0.1206 0.0783 0.2203 -0.4406 0.0993 0.1011 -0.0317
## Information Ratio   0.4017 0.2628 0.5990 -0.9407 0.4482 0.5062 -0.0632
## Treynor Ratio       0.2857 0.2725 1.0080 -0.3310 0.2406 0.1996  0.0933
##                         NA     NA     NA       NA     NA     NA       NA
## Alpha                0.0001 0.0015 0.0003 -0.0001 0.0002 0.0006  0.0000
## Beta                 1.1872 0.9321 0.7066  0.5556 1.1005 1.2817  1.0621
## Beta+                1.3471 0.9699 0.5460  0.4279 1.0187 1.1947  1.0036
## Beta-                0.9332 0.7783 0.6527  0.6650 1.1005 1.2530  1.0333
## R-squared            0.4722 0.3531 0.2544  0.1775 0.7251 0.6846  0.7004
## Annualized Alpha     0.0210 0.4513 0.0907 -0.0258 0.0466 0.1642 -0.0003
## Correlation          0.6871 0.5942 0.5044  0.4213 0.8515 0.8274  0.8369
## Correlation p-value  0.0000 0.0000 0.0000  0.0000 0.0000 0.0000  0.0000
## Tracking Error       0.3298 0.3279 0.3231  0.3316 0.1780 0.2376  0.1813
## Active Premium      -0.0179 0.4151 0.0103 -0.1282 0.0445 0.1816 -0.0127
## Information Ratio   -0.0542 1.2659 0.0320 -0.3866 0.2498 0.7642 -0.0700
## Treynor Ratio        0.0948 0.5784 0.1973  0.0039 0.1589 0.2434  0.1108
##                         NA     NA     NA     NA     NA     NA       NA
## Alpha               -0.0004 0.0013 0.0005 0.0003 0.0002 0.0008 -0.0001
## Beta                 0.7100 0.4622 1.2140 1.1649 1.3296 0.8235  1.1285
## Beta+                0.7037 0.3646 1.1391 1.2268 1.3379 0.8160  1.0994
## Beta-                0.7315 0.4064 1.1488 0.7915 1.4536 1.0492  1.0515
## R-squared            0.5187 0.1181 0.6465 0.3608 0.4887 0.4116  0.6864
## Annualized Alpha    -0.0870 0.3838 0.1208 0.0762 0.0553 0.2124 -0.0347
## Correlation          0.7202 0.3436 0.8041 0.6007 0.6991 0.6416  0.8285
## Correlation p-value  0.0000 0.0000 0.0000 0.0000 0.0000 0.0000  0.0000
## Tracking Error       0.1931 0.3559 0.2398 0.4052 0.3636 0.2431  0.2010
## Active Premium      -0.1430 0.2701 0.1243 0.0088 0.0206 0.1848 -0.0484
## Information Ratio   -0.7408 0.7589 0.5182 0.0216 0.0566 0.7601 -0.2408
## Treynor Ratio       -0.0178 0.8545 0.2098 0.1194 0.1135 0.1319  0.0726
##                         NA     NA     NA     NA       NA       NA       NA
## Alpha               0.0016 0.0001 0.0002 0.0008 -0.0005 -0.0005 -0.0004
## Beta                0.8285 1.4968 1.3302 0.8775  1.5411  1.0966  1.1944
## Beta+               0.7827 1.4061 1.3770 0.8875  1.5876  1.0691  1.1587
## Beta-               0.8885 1.4436 1.2228 0.8511  1.4078  1.0589  1.2113
## R-squared           0.2234 0.6638 0.6221 0.4431  0.6178  0.6383  0.7275
## Annualized Alpha    0.5012 0.0323 0.0514 0.2300 -0.1223 -0.1247 -0.0944
## Correlation         0.4727 0.8147 0.7887 0.6657  0.7860  0.7989  0.8529
## Correlation p-value 0.0000 0.0000 0.0000 0.0000  0.0000  0.0000  0.0000
## Tracking Error      0.4039 0.3055 0.2828 0.2576  0.3450  0.2160  0.1966
## Active Premium      0.4114 0.0330 0.0457 0.2005 -0.1487 -0.1555 -0.1087
## Information Ratio   1.0187 0.1080 0.1616 0.7783 -0.4310 -0.7198 -0.5529
## Treynor Ratio       0.6540 0.1091 0.1324 0.3771 -0.0119 -0.0229  0.0181
##                         NA
## Alpha               0.0002
## Beta                1.0330
## Beta+               0.9561
## Beta-               1.0079
## R-squared           0.6314
## Annualized Alpha    0.0393
```

```
## Correlation         0.7946
## Correlation p-value 0.0000
## Tracking Error      0.2053
## Active Premium      0.0235
## Information Ratio   0.1143
## Treynor Ratio       0.1489
```

CAPM - Distinct for each stock

```
## Error: improper length of one or more arguments to merge.xts
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	0001.HK	0002.HK	0003.HK	0004.HK	0005.HK	0006.HK
Alpha	0.000	0.000	0.000	0.001	0.000	0.000
Beta	0.989	0.147	0.378	1.112	1.121	0.114
Beta+	0.955	0.043	0.276	1.113	1.212	0.060
Beta-	0.969	0.188	0.410	1.088	1.311	0.126
R-squared	0.639	0.079	0.179	0.494	0.560	0.028
Annualized Alpha	0.000	0.051	0.108	0.167	-0.124	0.088
Correlation	0.799	0.281	0.423	0.703	0.748	0.167
Correlation p-value	0.000	0.000	0.000	0.000	0.000	0.000
Tracking Error	0.193	0.257	0.265	0.294	0.260	0.289
Active Premium	-0.022	-0.065	0.014	0.147	-0.164	-0.040
Information Ratio	-0.116	-0.254	0.053	0.500	-0.632	-0.137
Treynor Ratio	0.109	0.444	0.382	0.249	-0.030	0.795

	0011.HK	0012.HK	0013.HK	0016.HK	0017.HK	0019.HK
Alpha	0.000	0.000	0.000	0.000	0.000	0.000
Beta	0.639	1.019	0.948	1.004	1.136	0.785
Beta+	0.703	1.049	0.864	0.968	1.059	0.852
Beta-	0.673	0.992	0.987	0.979	1.164	0.722
R-squared	0.452	0.556	0.527	0.642	0.503	0.384
Annualized Alpha	-0.075	0.020	0.132	0.059	-0.050	0.077
Correlation	0.673	0.746	0.726	0.801	0.709	0.620
Correlation p-value	0.000	0.000	0.000	0.000	0.000	0.000
Tracking Error	0.205	0.236	0.234	0.195	0.296	0.264
Active Premium	-0.139	-0.007	0.109	0.044	-0.090	0.022
Information Ratio	-0.676	-0.028	0.468	0.228	-0.304	0.084
Treynor Ratio	-0.013	0.122	0.253	0.174	0.036	0.194

	0023.HK	0066.HK	0083.HK	0101.HK	0144.HK	0151.HK
Alpha	0.000	0.000	0.000	0.000	0.000	0.001
Beta	0.940	0.509	1.166	1.092	1.310	0.431
Beta+	1.019	0.430	1.135	1.246	1.257	0.204
Beta-	0.927	0.503	1.206	0.990	1.220	0.513
R-squared	0.462	0.338	0.515	0.464	0.537	0.096
Annualized Alpha	0.125	0.074	0.049	0.054	0.113	0.305
Correlation	0.680	0.581	0.718	0.681	0.733	0.311
Correlation p-value	0.000	0.000	0.000	0.000	0.000	0.000
Tracking Error	0.264	0.225	0.297	0.306	0.326	0.374
Active Premium	0.092	0.003	0.022	0.017	0.097	0.178
Information Ratio	0.348	0.013	0.073	0.056	0.297	0.477
Treynor Ratio	0.236	0.262	0.130	0.135	0.174	0.716

	0267.HK	0291.HK	0293.HK	0322.HK	0330.HK	0386.HK
Alpha	0.000	0.001	0.000	0.001	-0.002	0.000
Beta	1.081	0.878	0.766	0.348	0.937	0.955
Beta+	1.032	0.777	0.732	0.264	0.736	0.808
Beta-	0.984	0.906	0.755	0.386	1.141	0.992
R-squared	0.403	0.369	0.318	0.071	0.213	0.557
Annualized Alpha	0.075	0.170	0.141	0.354	-0.314	0.119
Correlation	0.635	0.607	0.564	0.267	0.462	0.746
Correlation p-value	0.000	0.000	0.000	0.000	0.000	0.000
Tracking Error	0.342	0.300	0.298	0.368	0.468	0.222
Active Premium	0.025	0.121	0.078	0.220	-0.441	0.099
Information Ratio	0.073	0.402	0.263	0.599	-0.941	0.448
Treynor Ratio	0.144	0.286	0.272	1.008	-0.331	0.241

	0388.HK	0494.HK	0688.HK	0700.HK	0762.HK	0836.HK
Alpha	0.000	0.000	0.000	0.002	0.000	0.000

```
## Beta                  1.159   0.971   1.187   0.932   0.707   0.556
## Beta+                 1.246   0.950   1.347   0.970   0.546   0.428
## Beta-                 1.111   0.869   0.933   0.778   0.653   0.665
## R-squared             0.704   0.204   0.472   0.353   0.254   0.178
## Annualized Alpha      0.095   0.132   0.021   0.451   0.091  -0.026
## Correlation           0.839   0.452   0.687   0.594   0.504   0.421
## Correlation p-value   0.000   0.000   0.000   0.000   0.000   0.000
## Tracking Error        0.200   0.501   0.330   0.328   0.323   0.332
## Active Premium        0.101  -0.032  -0.018   0.415   0.010  -0.128
## Information Ratio     0.506  -0.063  -0.054   1.266   0.032  -0.387
## Treynor Ratio         0.200   0.093   0.095   0.578   0.197   0.004
##                     0857.HK 0883.HK 0939.HK 0941.HK 1044.HK 1088.HK
## Alpha                 0.000   0.001   0.000   0.000   0.001   0.000
## Beta                  1.101   1.282   1.062   0.710   0.462   1.214
## Beta+                 1.019   1.195   1.004   0.704   0.365   1.139
## Beta-                 1.101   1.253   1.033   0.732   0.406   1.149
## R-squared             0.725   0.685   0.700   0.519   0.118   0.646
## Annualized Alpha      0.047   0.164   0.000  -0.087   0.384   0.121
## Correlation           0.852   0.827   0.837   0.720   0.344   0.804
## Correlation p-value   0.000   0.000   0.000   0.000   0.000   0.000
## Tracking Error        0.178   0.238   0.181   0.193   0.356   0.240
## Active Premium        0.044   0.182  -0.013  -0.143   0.270   0.124
## Information Ratio     0.250   0.764  -0.070  -0.741   0.759   0.518
## Treynor Ratio         0.159   0.243   0.111  -0.018   0.854   0.210
##                     1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK
## Alpha                 0.000   0.000   0.001   0.000   0.002   0.000
## Beta                  1.165   1.330   0.824   1.129   0.828   1.497
## Beta+                 1.227   1.338   0.816   1.099   0.783   1.406
## Beta-                 0.792   1.454   1.049   1.052   0.888   1.444
## R-squared             0.361   0.489   0.412   0.686   0.223   0.664
## Annualized Alpha      0.076   0.055   0.212  -0.035   0.501   0.032
## Correlation           0.601   0.699   0.642   0.828   0.473   0.815
## Correlation p-value   0.000   0.000   0.000   0.000   0.000   0.000
## Tracking Error        0.405   0.364   0.243   0.201   0.404   0.306
## Active Premium        0.009   0.021   0.185  -0.048   0.411   0.033
## Information Ratio     0.022   0.057   0.760  -0.241   1.019   0.108
## Treynor Ratio         0.119   0.114   0.132   0.073   0.654   0.109
##                     2318.HK 2388.HK 2600.HK 2628.HK 3328.HK 3988.HK
## Alpha                 0.000   0.001   0.000   0.000   0.000   0.000
## Beta                  1.330   0.878   1.541   1.097   1.194   1.033
## Beta+                 1.377   0.888   1.588   1.069   1.159   0.956
## Beta-                 1.223   0.851   1.408   1.059   1.211   1.008
## R-squared             0.622   0.443   0.618   0.638   0.728   0.631
## Annualized Alpha      0.051   0.230  -0.122  -0.125  -0.094   0.039
## Correlation           0.789   0.666   0.786   0.799   0.853   0.795
## Correlation p-value   0.000   0.000   0.000   0.000   0.000   0.000
## Tracking Error        0.283   0.258   0.345   0.216   0.197   0.205
## Active Premium        0.046   0.200  -0.149  -0.156  -0.109   0.024
## Information Ratio     0.162   0.778  -0.431  -0.720  -0.553   0.114
## Treynor Ratio         0.132   0.377  -0.012  -0.023   0.018   0.149
```

3 HSI Components Risk

3.1 Correlation

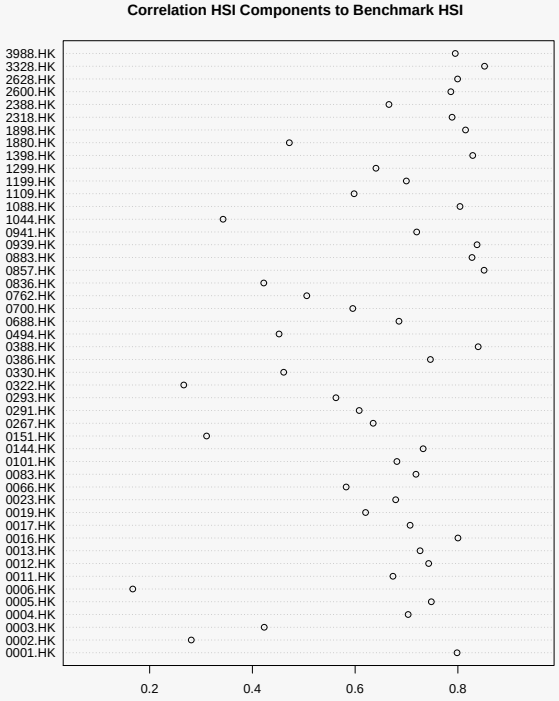
Correlation Combined

```
##                       Correlation p-value Lower CI Upper CI
## HSI Components to HSI      0.0382   0.555   -0.128   0.2024
```

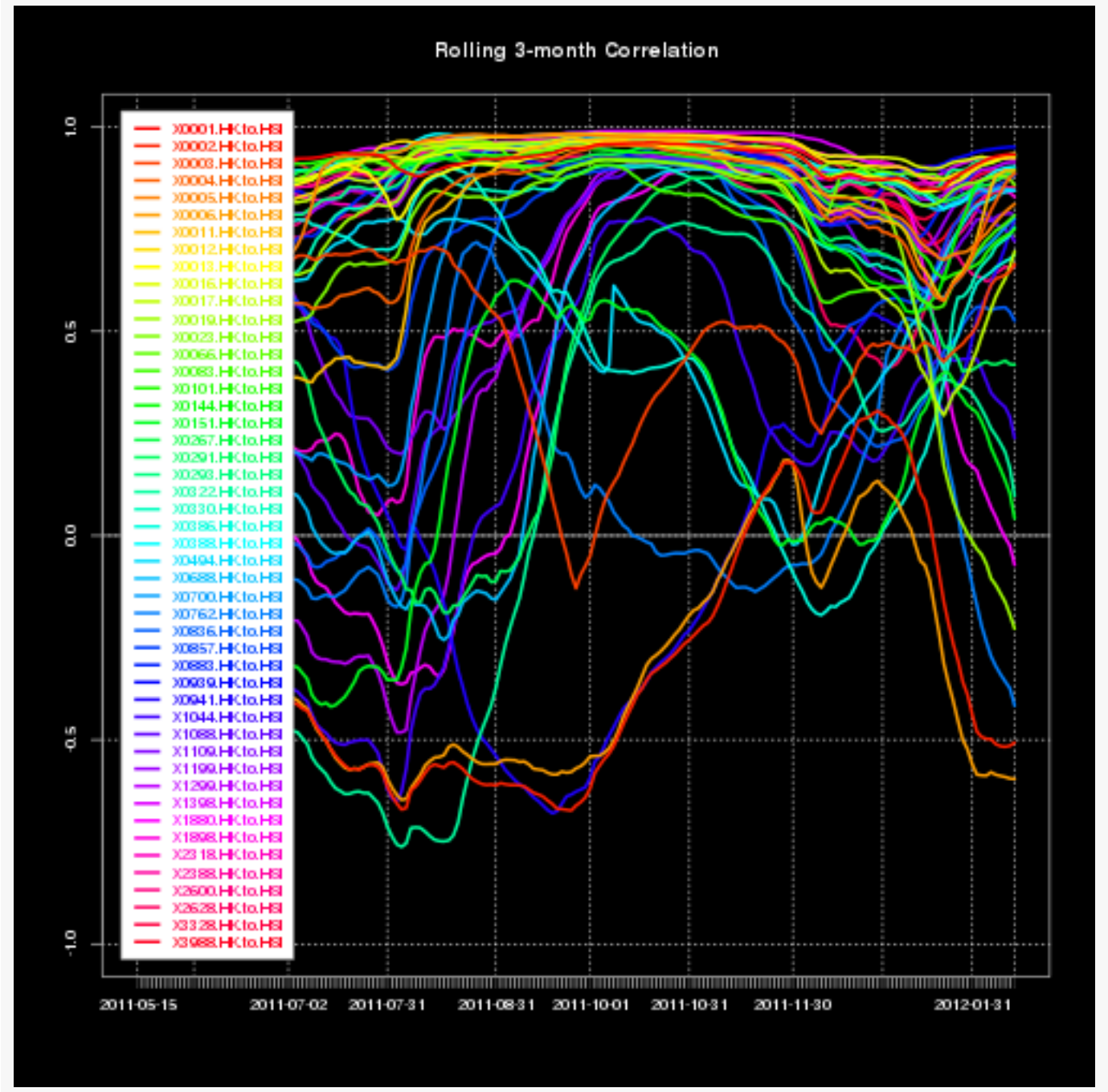
Correlation - Distinct

```
##         Correlation p-value Lower CI Upper CI
## 0001.HK      0.7984       0   0.7622   0.8296
## 0002.HK      0.2810       0   0.1935   0.3640
## 0003.HK      0.4230       0   0.3440   0.4961
## 0004.HK      0.7032       0   0.6532   0.7471
## 0005.HK      0.7483       0   0.7046   0.7864
## 0006.HK      0.1671       0   0.0757   0.2556
## 0011.HK      0.6736       0   0.6197   0.7211
## 0012.HK      0.7431       0   0.6986   0.7819
## 0013.HK      0.7264       0   0.6796   0.7673
## 0016.HK      0.8001       0   0.7642   0.8311
## 0017.HK      0.7070       0   0.6575   0.7504
## 0019.HK      0.6203       0   0.5600   0.6742
## 0023.HK      0.6789       0   0.6257   0.7258
## 0066.HK      0.5825       0   0.5179   0.6405
## 0083.HK      0.7184       0   0.6704   0.7604
## 0101.HK      0.6813       0   0.6284   0.7279
## 0144.HK      0.7324       0   0.6864   0.7725
## 0151.HK      0.3108       0   0.2247   0.3920
## 0267.HK      0.6351       0   0.5764   0.6872
## 0291.HK      0.6079       0   0.5462   0.6632
## 0293.HK      0.5626       0   0.4959   0.6227
## 0322.HK      0.2664       0   0.1783   0.3503
## 0330.HK      0.4609       0   0.3848   0.5307
## 0386.HK      0.7465       0   0.7026   0.7848
## 0388.HK      0.8395       0   0.8099   0.8649
## 0494.HK      0.4519       0   0.3745   0.5230
## 0688.HK      0.6853       0   0.6329   0.7314
## 0700.HK      0.5954       0   0.5323   0.6520
## 0762.HK      0.5058       0   0.4337   0.5715
## 0836.HK      0.4221       0   0.3430   0.4952
## 0857.HK      0.8510       0   0.8233   0.8747
## 0883.HK      0.8275       0   0.7959   0.8546
## 0939.HK      0.8373       0   0.8073   0.8630
## 0941.HK      0.7198       0   0.6720   0.7616
## 1044.HK      0.3429       0   0.2588   0.4218
## 1088.HK      0.8041       0   0.7688   0.8345
## 1109.HK      0.5980       0   0.5351   0.6543
## 1199.HK      0.6997       0   0.6492   0.7440
## 1299.HK      0.6405       0   0.5474   0.7180
## 1398.HK      0.8289       0   0.7976   0.8558
## 1880.HK      0.4719       0   0.3967   0.5408
## 1898.HK      0.8149       0   0.7813   0.8438
## 2318.HK      0.7887       0   0.7510   0.8213
## 2388.HK      0.6658       0   0.6109   0.7143
## 2600.HK      0.7863       0   0.7482   0.8192
## 2628.HK      0.7994       0   0.7634   0.8305
```

```
## 3328.HK      0.8519       0   0.8243   0.8754
## 3988.HK      0.7949       0   0.7582   0.8266
```



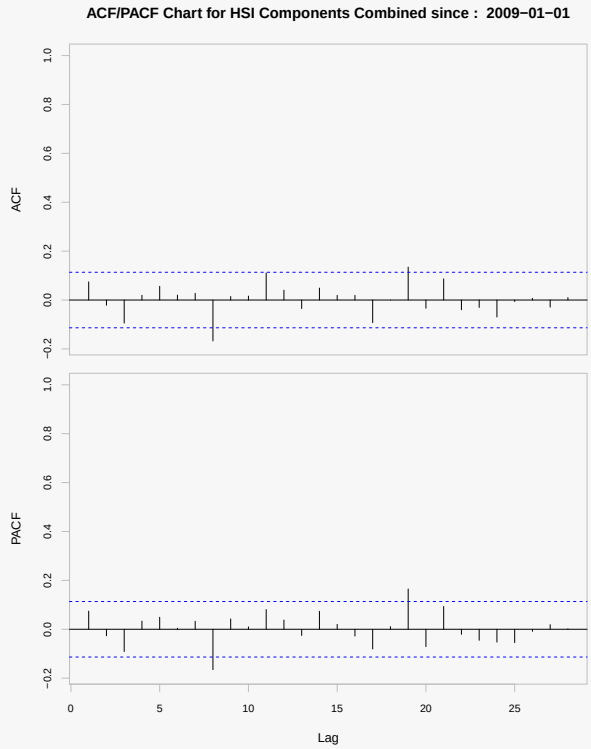
3 Month Rolling Correlation



3.2 Autocorrelation Coefficients - Combined

Autocorrelation Combined

```
##                  rho1    rho2    rho3   rho4   rho5   rho6 Q(6) p-value
## daily.returns 0.0743 -0.0211 -0.0942 0.0195 0.0562 0.0201       0.4328
```



3.3 Downside Risk - Combined

Downside Risk Combined

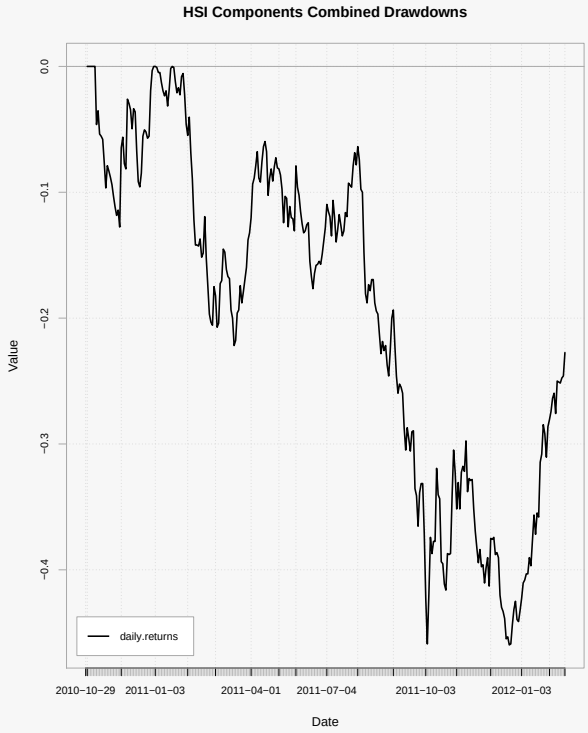
```
##                                HSI Components dailyReturn
## Semi Deviation                                      0.0224
## Gain Deviation                                      0.0181
## Loss Deviation                                      0.0153
## Downside Deviation (MAR=210%)                       0.0260
## Downside Deviation (Rf=0%)                          0.0227
## Downside Deviation (0%)                             0.0227
## Maximum Drawdown                                    0.4597
## Historical VaR (95%)                               -0.0361
## Historical ES (95%)                                -0.0511
## Modified VaR (95%)                                 -0.0369
## Modified ES (95%)                                  -0.0474
```

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    255       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%)          0.02274
```

3.6 Autocorrelation Coefficients - Distinct

```
##             rho1    rho2    rho3    rho4    rho5    rho6 Q(6) p-value
## X0001.HK  0.0535 -0.0636  0.0172 -0.0334  0.0113  0.0137       0.3476
## X0002.HK -0.1238 -0.0460 -0.0072  0.0198  0.0144 -0.0300       0.0221
## X0003.HK -0.0995 -0.0156 -0.0208  0.0481  0.0144  0.0288       0.0934
## X0004.HK  0.0064 -0.0333 -0.0292 -0.0297  0.0913 -0.0366       0.1333
## X0005.HK -0.0239 -0.0235  0.0601  0.0338 -0.0478  0.0303       0.3129
## X0006.HK -0.0843 -0.0615  0.0148 -0.0238  0.0049 -0.0741       0.0372
## X0011.HK  0.1155  0.0162 -0.0185  0.0028 -0.0475 -0.0807       0.0071
## X0012.HK  0.0750 -0.0279 -0.0517 -0.0060  0.0458  0.0041       0.1890
## X0013.HK  0.0012  0.0315  0.0117 -0.0137  0.0244 -0.0258       0.9185
## X0016.HK  0.0510 -0.0579  0.0228 -0.0046  0.0409  0.0156       0.3644
## X0017.HK  0.0781  0.0195  0.0119  0.0285  0.0502 -0.0186       0.2365
## X0019.HK  0.0412  0.0465 -0.0260 -0.1041 -0.0056  0.0176       0.0568
## X0023.HK  0.0881 -0.0057 -0.0084 -0.0072 -0.0494 -0.0380       0.1634
## X0066.HK -0.0736 -0.0009  0.0534 -0.0219 -0.0071 -0.0158       0.3178
## X0083.HK  0.1006 -0.0584 -0.0378  0.0055  0.0453 -0.0005       0.0390
## X0101.HK -0.0718 -0.0209  0.0151 -0.0414 -0.0592  0.0214       0.1761
## X0144.HK  0.0620 -0.0081  0.0007 -0.0515 -0.1042  0.0023       0.0346
## X0151.HK -0.0179 -0.0265 -0.0863 -0.1023  0.0117 -0.0009       0.0213
## X0267.HK  0.1223  0.0374 -0.0544 -0.0216  0.0426  0.0427       0.0057
## X0291.HK -0.0354 -0.0199  0.0063 -0.0445  0.0110 -0.0041       0.8133
## X0293.HK  0.0251 -0.0459 -0.0681 -0.0545  0.0746  0.0714       0.0118
## X0322.HK -0.0114  0.0356 -0.0909 -0.0018 -0.0154 -0.0229       0.2291
## X0330.HK  0.0451  0.1289 -0.0113  0.0433 -0.0043 -0.0180       0.0121
## X0386.HK -0.0223 -0.0252 -0.0396 -0.0160 -0.0088  0.0329       0.7829
## X0388.HK  0.0974 -0.0120  0.0316 -0.0112  0.0084 -0.0145       0.1990
## X0494.HK -0.0111 -0.0314 -0.0128 -0.0235 -0.0114  0.0080       0.9560
## X0688.HK  0.0791 -0.0600 -0.0570 -0.0437 -0.0028  0.0078       0.0680
## X0700.HK  0.0208 -0.0962  0.0008 -0.0888  0.0048  0.0367       0.0208
## X0762.HK -0.0494 -0.0731 -0.0336 -0.0626  0.0340 -0.0282       0.0711
## X0836.HK -0.0535 -0.0387 -0.0017  0.0032 -0.0106 -0.0165       0.7172
## X0857.HK  0.0437 -0.0155  0.0378 -0.0030 -0.0061  0.0042       0.8297
## X0883.HK  0.0434 -0.0514 -0.0119 -0.0261 -0.0562  0.0016       0.3558
## X0939.HK  0.0013  0.0040  0.0192 -0.0572 -0.0308 -0.0341       0.6085
## X0941.HK -0.0163 -0.0174  0.0057 -0.0944  0.0044 -0.0251       0.2437
## X1044.HK -0.0330 -0.0473 -0.0979 -0.0593 -0.0412  0.0154       0.0243
## X1088.HK  0.0473 -0.0029 -0.0265 -0.0344  0.0277 -0.0359       0.5664
## X1109.HK  0.0279 -0.0255 -0.0556 -0.0875  0.0149 -0.0021       0.1394
## X1199.HK  0.0701  0.0489 -0.0032 -0.0659  0.0100  0.0338       0.1226
## X1299.HK -0.0136 -0.0857  0.0174 -0.0778 -0.1101 -0.0056       0.2030
## X1398.HK  0.0194 -0.0023  0.0602 -0.0224 -0.0184 -0.0408       0.5339
## X1880.HK  0.0081 -0.0862 -0.0848 -0.0252 -0.0379 -0.0356       0.0290
## X1898.HK  0.0935  0.0160 -0.0010  0.0054 -0.0464 -0.0204       0.1724
## X2318.HK  0.0667 -0.0460 -0.0691 -0.0384  0.0702  0.0068       0.0313
## X2388.HK  0.0721  0.0266  0.0560 -0.0008 -0.0387 -0.0155       0.2108
## X2600.HK  0.0660 -0.0323 -0.0335  0.0046  0.0075  0.0015       0.5273
## X2628.HK -0.0028 -0.0187  0.0363 -0.0566 -0.0073 -0.0058       0.6937
```

```
## X3328.HK  0.0227  0.0337 -0.0074 -0.0596  0.0053 -0.0172       0.6292
## X3988.HK  0.0391 -0.0218  0.0387 -0.0432 -0.0075 -0.0703       0.2320
```

3.7 Downside Deviation - Distinct

```
##                                0001.HK 0002.HK 0003.HK 0004.HK 0005.HK
## Downside Deviation (MAR = 0%)  0.0192  0.0089  0.0155  0.0242  0.0255
##                                0006.HK 0011.HK 0012.HK 0013.HK 0016.HK
## Downside Deviation (MAR = 0%)  0.0111  0.0151  0.0214  0.0192  0.0197
##                                0017.HK 0019.HK 0023.HK 0066.HK 0083.HK
## Downside Deviation (MAR = 0%)  0.0246   0.021  0.0208  0.0133  0.0256
##                                0101.HK 0144.HK 0151.HK 0267.HK 0291.HK
## Downside Deviation (MAR = 0%)  0.0253   0.027  0.0218  0.0256  0.0228
##                                0293.HK 0322.HK 0330.HK 0386.HK 0388.HK
## Downside Deviation (MAR = 0%)  0.0214  0.0201  0.0354  0.0207  0.0199
##                                0494.HK 0688.HK 0700.HK 0762.HK 0836.HK
## Downside Deviation (MAR = 0%)  0.0384  0.0261  0.0247  0.0228  0.0204
##                                0857.HK 0883.HK 0939.HK 0941.HK 1044.HK
## Downside Deviation (MAR = 0%)  0.0211  0.0241   0.021   0.016  0.0204
##                                1088.HK 1109.HK 1199.HK 1299.HK 1398.HK
## Downside Deviation (MAR = 0%)  0.0245  0.0291   0.029  0.0199  0.0217
##                                1880.HK 1898.HK 2318.HK 2388.HK 2600.HK
## Downside Deviation (MAR = 0%)  0.0273  0.0301  0.0269  0.0199  0.0299
##                                2628.HK 3328.HK 3988.HK
## Downside Deviation (MAR = 0%)   0.022  0.0226  0.0219
```

4 General Statistics

Statistics Distinct

	Observations	NAs	Minimum	Quartile 1	Median	Arithmetic Mean
X0001.HK.Close	774	12	56.00	91.350	98.075	99.968
X0002.HK.Close	774	12	51.10	52.600	57.300	59.209
X0003.HK.Close	774	12	10.78	17.220	18.130	17.596
X0004.HK.Close	774	12	15.20	36.763	41.700	41.781
X0005.HK.Close	774	12	33.00	65.900	78.925	74.904
X0006.HK.Close	774	12	41.10	43.500	47.150	48.989
X0011.HK.Close	774	12	67.00	102.525	110.500	109.441
X0012.HK.Close	774	12	23.75	42.638	48.425	46.925
X0013.HK.Close	774	12	36.40	52.600	57.950	63.997
X0016.HK.Close	774	12	55.80	100.125	111.000	108.137
X0017.HK.Close	774	12	6.20	9.595	13.490	12.717
X0019.HK.Close	774	12	42.90	84.562	92.475	92.565
X0023.HK.Close	774	12	12.34	26.625	28.950	28.195
X0066.HK.Close	774	12	16.14	25.150	26.850	26.029
X0083.HK.Close	774	12	5.60	11.880	13.600	13.068
X0101.HK.Close	774	12	13.66	25.650	29.025	28.606
X0144.HK.Close	774	12	12.20	23.050	26.350	25.951
X0151.HK.Close	774	12	2.77	4.662	6.175	5.826
X0267.HK.Close	774	12	7.18	14.220	17.290	17.081
X0291.HK.Close	774	12	10.66	23.812	27.900	26.071
X0293.HK.Close	774	12	6.98	12.570	14.770	15.171
X0322.HK.Close	774	12	8.27	16.225	19.200	18.178
X0330.HK.Close	774	12	7.93	31.587	42.450	39.188
X0386.HK.Close	774	12	3.65	6.190	6.785	6.816
X0388.HK.Close	774	12	54.60	122.800	136.150	136.525
X0494.HK.Close	764	22	11.60	16.915	31.975	29.113
X0688.HK.Close	774	12	9.41	14.245	15.440	15.201
X0700.HK.Close	783	3	41.80	127.450	155.400	147.771
X0762.HK.Close	781	5	8.31	9.630	10.980	11.893
X0836.HK.Close	774	12	11.10	14.220	15.360	15.438
X0857.HK.Close	774	12	5.10	8.682	9.375	9.305
X0883.HK.Close	774	12	6.08	11.110	13.220	13.558
X0939.HK.Close	774	12	3.66	5.610	6.260	6.116
X0941.HK.Close	774	12	63.00	73.250	75.850	75.635
X1044.HK.Close	786	0	24.25	47.250	58.750	56.131
X1088.HK.Close	774	12	13.90	29.962	33.225	31.634
X1109.HK.Close	774	12	7.50	12.880	14.560	14.399
X1199.HK.Close	774	12	5.40	9.393	10.950	11.119
X1299.HK.Close	321	465	19.86	22.700	24.000	24.392
X1398.HK.Close	774	12	3.03	4.970	5.725	5.462
X1880.HK.Close	774	12	2.98	7.992	11.830	11.026
X1898.HK.Close	774	12	4.43	9.473	10.580	10.444
X2318.HK.Close	774	12	30.35	57.913	64.350	65.394
X2388.HK.Close	774	12	6.30	16.685	18.430	18.712
X2600.HK.Close	774	12	3.20	5.600	7.020	6.673
X2628.HK.Close	774	12	17.24	25.625	30.450	29.654
X3328.HK.Close	774	12	4.17	6.223	8.000	7.594
X3988.HK.Close	774	12	1.84	3.058	3.930	3.663

	Geometric Mean	Quartile 3	Maximum	SE Mean	LCL Mean (0.95)
X0001.HK.Close	98.605	113.900	135.70	0.5836	98.822
X0002.HK.Close	58.855	64.050	75.00	0.2374	58.743
X0003.HK.Close	17.461	18.980	21.00	0.0751	17.449
X0004.HK.Close	40.057	51.200	62.00	0.3989	40.998

```
## X0005.HK.Close          73.868     83.100   98.00  0.4249           74.070
## X0006.HK.Close          48.633     53.700   64.80  0.2193           48.558
## X0011.HK.Close         108.673    117.600  134.00  0.4553          108.547
## X0012.HK.Close          46.108     53.150   60.50  0.2957           46.344
## X0013.HK.Close          62.055     77.925   95.90  0.5758           62.866
## X0016.HK.Close         106.410    118.700  146.30  0.6503          106.860
## X0017.HK.Close          12.258     15.315   18.54  0.1193           12.483
## X0019.HK.Close          90.123    108.950  136.40  0.7189           91.153
## X0023.HK.Close          27.656     32.150   35.90  0.1825           27.837
## X0066.HK.Close          25.804     28.250   31.15  0.1173           25.799
## X0083.HK.Close          12.803     14.800   18.56  0.0897           12.892
## X0101.HK.Close          28.010     32.350   40.30  0.2013           28.211
## X0144.HK.Close          25.410     28.900   37.55  0.1824           25.593
## X0151.HK.Close           5.673      6.968    8.19  0.0492            5.729
## X0267.HK.Close          16.587     20.600   24.40  0.1429           16.800
## X0291.HK.Close          25.056     30.750   35.25  0.2359           25.608
## X0293.HK.Close          14.642     18.290   24.05  0.1459           14.884
## X0322.HK.Close          17.533     20.900   25.95  0.1621           17.860
## X0330.HK.Close          35.284     50.263   64.30  0.5295           38.148
## X0386.HK.Close           6.734      7.620    9.64  0.0393            6.739
## X0388.HK.Close         132.633    160.575  197.50  1.0819          134.401
## X0494.HK.Close          26.695     38.650   51.90  0.4189           28.291
## X0688.HK.Close          15.073     16.640   19.44  0.0704           15.063
## X0700.HK.Close         137.592    180.800  225.00  1.6881          144.457
## X0762.HK.Close          11.664     14.300   17.40  0.0902           11.716
## X0836.HK.Close          15.354     16.635   20.15  0.0600           15.321
## X0857.HK.Close           9.200     10.160   12.36  0.0505            9.206
## X0883.HK.Close          13.119     16.640   20.95  0.1242           13.314
## X0939.HK.Close           6.048      6.808    8.28  0.0337            6.050
## X0941.HK.Close          75.531     78.088   91.45  0.1438           75.353
## X1044.HK.Close          53.948     68.000   78.25  0.5109           55.128
## X1088.HK.Close          30.979     35.250   40.80  0.2095           31.223
## X1109.HK.Close          14.160     16.340   20.00  0.0934           14.216
## X1199.HK.Close          10.882     12.700   16.76  0.0848           10.952
## X1299.HK.Close          24.317     26.150   29.55  0.1097           24.177
## X1398.HK.Close           5.398      5.980    7.03  0.0309            5.401
## X1880.HK.Close          10.269     14.240   17.54  0.1384           10.755
## X1898.HK.Close          10.209     11.760   15.86  0.0785           10.290
## X2318.HK.Close          63.915     76.300   94.30  0.4839           64.444
## X2388.HK.Close          17.925     22.900   28.95  0.1840           18.351
## X2600.HK.Close           6.453      7.870   10.66  0.0624            6.550
## X2628.HK.Close          29.026     34.500   41.00  0.2145           29.233
## X3328.HK.Close           7.443      8.700   10.56  0.0556            7.485
## X3988.HK.Close           3.603      4.140    5.00  0.0255            3.613
##                 UCL Mean (0.95)  Variance   Stdev Skewness Kurtosis
## X0001.HK.Close          101.113  263.5838 16.2353  -0.0941  -0.1382
## X0002.HK.Close           59.675   43.6360  6.6058   0.3796  -1.2300
## X0003.HK.Close           17.744    4.3673  2.0898  -1.6167   2.0472
## X0004.HK.Close           42.564  123.1316 11.0965  -0.4700  -0.2158
## X0005.HK.Close           75.738  139.7326 11.8209  -0.7799   0.1917
## X0006.HK.Close           49.419   37.2370  6.1022   0.6497  -0.8033
## X0011.HK.Close          110.335  160.4655 12.6675  -0.5227  -0.0099
## X0012.HK.Close           47.505   67.6955  8.2277  -0.8819   0.2492
## X0013.HK.Close           65.127  256.6481 16.0202   0.3564  -1.0203
## X0016.HK.Close          109.413  327.3212 18.0920  -0.8457   0.6423
## X0017.HK.Close           12.951   11.0094  3.3180  -0.5284  -0.9270
## X0019.HK.Close           93.976  400.0416 20.0010  -0.4539   0.0024
```

```
## X0023.HK.Close          28.554   25.7925  5.0786  -1.2151   1.0367
## X0066.HK.Close          26.259   10.6478  3.2631  -1.3672   1.2124
## X0083.HK.Close          13.244    6.2328  2.4966  -1.0202   0.7336
## X0101.HK.Close          29.001   31.3637  5.6003  -0.5253  -0.0007
## X0144.HK.Close          26.309   25.7460  5.0741  -0.5217   0.3100
## X0151.HK.Close           5.922    1.8754  1.3695  -0.5375  -0.8207
## X0267.HK.Close          17.361   15.8124  3.9765  -0.4408  -0.5939
## X0291.HK.Close          26.534   43.0707  6.5628  -1.0124  -0.1123
## X0293.HK.Close          15.457   16.4772  4.0592   0.1220  -0.7495
## X0322.HK.Close          18.497   20.3342  4.5093  -0.7962  -0.1999
## X0330.HK.Close          40.227  217.0336 14.7321  -0.7010  -0.5027
## X0386.HK.Close           6.893    1.1925  1.0920  -0.4116   0.4933
## X0388.HK.Close         138.649  905.9650 30.0993  -0.5599   0.3037
## X0494.HK.Close          29.935  134.0478 11.5779   0.0003  -1.4370
## X0688.HK.Close          15.339    3.8326  1.9577  -0.7312   0.0846
## X0700.HK.Close         151.085 2231.3457 47.2371  -0.7072  -0.2749
## X0762.HK.Close          12.070    6.3500  2.5199   0.7117  -0.9342
## X0836.HK.Close          15.556    2.7840  1.6685   0.1506  -0.3175
## X0857.HK.Close           9.404    1.9702  1.4036  -0.7206   0.7086
## X0883.HK.Close          13.802   11.9372  3.4550  -0.0692  -0.7406
## X0939.HK.Close           6.182    0.8779  0.9370  -0.7314   0.0548
## X0941.HK.Close          75.918   15.9979  3.9997   0.0059   0.7431
## X1044.HK.Close          57.134  205.1339 14.3225  -0.7475  -0.5810
## X1088.HK.Close          32.045   33.9687  5.8283  -1.3754   1.4009
## X1109.HK.Close          14.582    6.7592  2.5999  -0.4263  -0.1795
## X1199.HK.Close          11.285    5.5685  2.3598   0.0731  -0.5250
## X1299.HK.Close          24.608    3.8642  1.9658   0.2862  -1.0141
## X1398.HK.Close           5.523    0.7402  0.8604  -0.9535   0.3620
## X1880.HK.Close          11.298   14.8179  3.8494  -0.4450  -0.9238
## X1898.HK.Close          10.598    4.7673  2.1834  -0.5180   0.3157
## X2318.HK.Close          66.344  181.2311 13.4622  -0.2071  -0.3278
## X2388.HK.Close          19.073   26.2072  5.1193  -0.4139  -0.2478
## X2600.HK.Close           6.795    3.0174  1.7371  -0.4156  -0.7588
## X2628.HK.Close          30.076   35.6228  5.9685  -0.3740  -0.9653
## X3328.HK.Close           7.703    2.3885  1.5455  -0.4687  -0.9136
## X3988.HK.Close           3.713    0.5046  0.7104  -0.7984  -0.3496
```

4.1 Higher Moments - Distinct

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

```
##                 0001.HK 0002.HK 0003.HK 0004.HK 0005.HK 0006.HK 0011.HK
## CoSkewness       0.0000  0.0000  0.0000   0.000   0.000  0.0000  0.0000
## CoKurtosis       0.0000  0.0000  0.0000   0.000   0.000  0.0000  0.0000
## Beta CoVariance  0.9887  0.1470  0.3776   1.112   1.121  0.1142  0.6389
## Beta CoSkewness  1.0147 -0.5969 -0.4611   1.870   0.930 -0.1960  0.9730
## Beta CoKurtosis  0.9986  0.0865  0.3595   1.120   1.280  0.0890  0.7197
##                 0012.HK 0013.HK 0016.HK 0017.HK 0019.HK 0023.HK 0066.HK
## CoSkewness        0.000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## CoKurtosis        0.000  0.0000  0.0000  0.0000  0.0000  0.0000  0.0000
## Beta CoVariance   1.019  0.9476  1.0040  1.1363  0.7846  0.9397  0.5092
## Beta CoSkewness   2.075  0.0604  1.3891  0.5787  1.4467  1.8985  0.2137
## Beta CoKurtosis   1.075  0.9007  0.9864  1.1280  0.7974  0.9847  0.4532
##                 0083.HK 0101.HK 0144.HK 0151.HK 0267.HK 0291.HK 0293.HK
## CoSkewness        0.000   0.000   0.000  0.0000  0.0000  0.0000  0.0000
## CoKurtosis        0.000   0.000   0.000  0.0000  0.0000  0.0000  0.0000
## Beta CoVariance   1.166   1.092   1.310  0.4311  1.0805  0.8783  0.7658
## Beta CoSkewness   1.250   2.874   1.483 -1.5339  1.2888  0.1324  1.0505
## Beta CoKurtosis   1.172   1.166   1.208  0.3369  0.9848  0.7634  0.7537
##                 0322.HK 0330.HK 0386.HK 0388.HK 0494.HK 0688.HK 0700.HK
## CoSkewness       0.0000  0.0000  0.0000   0.000  0.0000   0.000  0.0000
## CoKurtosis       0.0000  0.0000  0.0000   0.000  0.0000   0.000  0.0000
## Beta CoVariance  0.3479  0.9372  0.9548   1.159  0.9712   1.187  0.9321
## Beta CoSkewness -0.1987 -0.8195 -0.1085   1.822  2.1768   3.879  1.6679
## Beta CoKurtosis  0.3078  0.8984  0.8895   1.145  0.9754   1.263  0.8976
##                 0762.HK 0836.HK 0857.HK 0883.HK 0939.HK 0941.HK 1044.HK
## CoSkewness       0.0000  0.0000  0.0000   0.000  0.0000  0.0000  0.0000
## CoKurtosis       0.0000  0.0000  0.0000   0.000  0.0000  0.0000  0.0000
## Beta CoVariance  0.7066  0.5556  1.1005   1.282  1.0621  0.7100  0.4622
## Beta CoSkewness -0.5716 -0.8457  0.5149   0.849  0.5854  0.6943  0.0193
## Beta CoKurtosis  0.5420  0.4930  1.0089   1.209  1.0421  0.7032  0.3954
##                 1088.HK 1109.HK 1199.HK 1299.HK 1398.HK 1880.HK 1898.HK
## CoSkewness       0.0000   0.000  0.0000  0.0000   0.000  0.0000  0.0000
## CoKurtosis       0.0000   0.000  0.0000  0.0000   0.000  0.0000  0.0000
## Beta CoVariance  1.2140   1.165  1.3296  0.8235   1.129  0.8285  1.4968
## Beta CoSkewness  0.9615   3.502  0.6742  1.7711   1.002  0.1898  0.9424
## Beta CoKurtosis  1.0928   1.141  1.2568  0.9855   1.067  0.7701  1.3887
##                 2318.HK 2388.HK 2600.HK 2628.HK 3328.HK 3988.HK
## CoSkewness        0.000  0.0000   0.000  0.0000   0.000  0.0000
## CoKurtosis        0.000  0.0000   0.000  0.0000   0.000  0.0000
## Beta CoVariance   1.330  0.8775   1.541  1.0966   1.194  1.0330
## Beta CoSkewness   2.125  0.8244   2.216  0.8932   0.979  0.2574
## Beta CoKurtosis   1.319  0.8493   1.449  1.0404   1.185  0.9703
```

4.2 Higher Moments - Combined

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

##                 HSI Components to HSI Combined
## CoSkewness                              0.0000
## CoKurtosis                              0.0000
## Beta CoVariance                         1.1862
## Beta CoSkewness                         0.5333
## Beta CoKurtosis                         1.1227
```

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     4.9066 1.45706 1.19903 1.17907 1.03522 1.00086
## Proportion of Variance 0.5016 0.04423 0.02995 0.02896 0.02233 0.02087
## Cumulative Proportion  0.5016 0.54579 0.57574 0.60470 0.62703 0.64790
##                           Comp.7  Comp.8 Comp.9 Comp.10 Comp.11 Comp.12
## Standard deviation     0.96681 0.94794 0.9191 0.89138 0.86338 0.84734
## Proportion of Variance 0.01947 0.01872 0.0176 0.01655 0.01553 0.01496
## Cumulative Proportion  0.66737 0.68609 0.7037 0.72024 0.73577 0.75073
##                        Comp.13 Comp.14 Comp.15 Comp.16 Comp.17 Comp.18
## Standard deviation     0.81867 0.80649 0.76816 0.76044  0.7495  0.7165
## Proportion of Variance 0.01396 0.01355 0.01229 0.01205  0.0117  0.0107
## Cumulative Proportion  0.76469 0.77824 0.79054 0.80258  0.8143  0.8250
##                        Comp.19 Comp.20  Comp.21  Comp.22  Comp.23  Comp.24
## Standard deviation     0.70818 0.70525 0.684286 0.655126 0.651147 0.644673
## Proportion of Variance 0.01045 0.01036 0.009755 0.008941 0.008833 0.008658
## Cumulative Proportion  0.83543 0.84579 0.855546 0.864488 0.873321 0.881979
##                           Comp.25  Comp.26  Comp.27  Comp.28  Comp.29
## Standard deviation     0.628331 0.619046 0.604338 0.595665 0.576395
## Proportion of Variance 0.008225 0.007984 0.007609 0.007392 0.006921
## Cumulative Proportion  0.890204 0.898188 0.905797 0.913189 0.920110
##                           Comp.30  Comp.31  Comp.32  Comp.33  Comp.34
## Standard deviation     0.565976 0.560333 0.534623 0.525917 0.511776
## Proportion of Variance 0.006674 0.006541 0.005955 0.005762 0.005457
## Cumulative Proportion  0.926784 0.933325 0.939280 0.945042 0.950498
##                           Comp.35  Comp.36  Comp.37  Comp.38  Comp.39
## Standard deviation     0.500133 0.494197 0.479970 0.461842 0.450242
## Proportion of Variance 0.005211 0.005088 0.004799 0.004444 0.004223
## Cumulative Proportion  0.955709 0.960798 0.965597 0.970041 0.974264
##                           Comp.40  Comp.41  Comp.42  Comp.43  Comp.44
## Standard deviation     0.436812 0.420521 0.391239 0.388305 0.371300
## Proportion of Variance 0.003975 0.003684 0.003189 0.003141 0.002872
## Cumulative Proportion  0.978239 0.981923 0.985112 0.988253 0.991126
##                           Comp.45  Comp.46  Comp.47  Comp.48
## Standard deviation     0.348307 0.327956 0.323140 0.304434
## Proportion of Variance 0.002527 0.002241 0.002175 0.001931
## Cumulative Proportion  0.993653 0.995894 0.998069 1.000000

##
## Loadings:
##          Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8 Comp.9
## X0001.HK -0.173        -0.169  0.153                -0.103         0.118
## X0002.HK         0.470         0.133  0.161         0.257
## X0003.HK         0.347         0.290 -0.126                        0.142
## X0004.HK -0.161        -0.133
## X0005.HK -0.166
## X0006.HK         0.484                 0.138         0.368         0.190
## X0011.HK -0.154        -0.149  0.230  0.109                0.182 -0.165
## X0012.HK -0.160        -0.178  0.108                -0.179         0.191
## X0013.HK -0.165        -0.124  0.131
## X0016.HK -0.172        -0.170                       -0.127 -0.105  0.197
## X0017.HK -0.145        -0.227                              -0.176  0.248
## X0019.HK -0.124                0.284        -0.165 -0.105 -0.225 -0.187
## X0023.HK -0.152                0.128  0.182                 0.216 -0.293
## X0066.HK -0.140  0.148         0.199        -0.169                -0.245
```

```
## X0083.HK -0.154        -0.225                       -0.103         0.248
## X0101.HK -0.153        -0.198               0.113         0.151
## X0144.HK -0.152               -0.108         0.139  0.108 -0.160  0.118
## X0151.HK        -0.107  0.471  0.241 -0.121 -0.195        -0.168  0.262
## X0267.HK -0.160                             -0.124
## X0291.HK -0.128                              0.112  0.168 -0.232  0.111
## X0293.HK -0.130 -0.119         0.114         0.228  0.117 -0.284 -0.257
## X0322.HK        -0.124  0.423  0.404                       0.257  0.187
## X0330.HK                            -0.424 -0.292  0.512 -0.159 -0.247
## X0386.HK -0.138  0.239  0.118 -0.177 -0.213  0.131 -0.215 -0.112
## X0388.HK -0.172                             -0.146
## X0494.HK                      -0.108        -0.295  0.230  0.377  0.306
## X0688.HK -0.154 -0.190        -0.132                0.149
## X0700.HK -0.137         0.131         0.253  0.170        -0.196
## X0762.HK -0.126  0.140  0.261 -0.147         0.144 -0.173        -0.111
## X0836.HK               -0.101  0.144 -0.660  0.332         0.176
## X0857.HK -0.156  0.167        -0.158 -0.114        -0.153
## X0883.HK -0.167               -0.146
## X0939.HK -0.174                                    -0.158
## X0941.HK -0.123  0.300  0.130                       -0.130 -0.180 -0.102
## X1044.HK -0.102 -0.118  0.322  0.174  0.194  0.169  0.142 -0.188
## X1088.HK -0.165         0.104
## X1109.HK -0.153 -0.227        -0.101                0.140
## X1199.HK -0.156               -0.220                0.109 -0.120  0.103
## X1299.HK -0.132                                    0.362         0.310 -0.101
## X1398.HK -0.180               -0.116               -0.105
## X1880.HK -0.130         0.115                      0.303  0.219
## X1898.HK -0.160                                   -0.196  0.109  0.120 -0.150
## X2318.HK -0.168               -0.108        -0.111 -0.101
## X2388.HK -0.162                      0.125                       -0.231
## X2600.HK -0.159               -0.153
## X2628.HK -0.160               -0.113        -0.190
## X3328.HK -0.174               -0.141
## X3988.HK -0.175                                    -0.111  0.125
##          Comp.10 Comp.11 Comp.12 Comp.13 Comp.14 Comp.15 Comp.16 Comp.17
## X0001.HK                                  0.112           0.107
## X0002.HK -0.125                    0.187                 -0.231
## X0003.HK          0.311           -0.300                  0.123  -0.126
## X0004.HK                                  0.228          -0.193   0.234
## X0005.HK                  0.202                           0.114
## X0006.HK -0.194  -0.359                           -0.231   0.149
## X0011.HK          0.115                   0.102
## X0012.HK                 -0.111   0.180          -0.106  -0.204
## X0013.HK  0.140                   -0.182   0.106   0.113
## X0016.HK
## X0017.HK                  0.330          -0.170          -0.176  -0.154
## X0019.HK         -0.417  -0.188  -0.275          -0.108  -0.125  -0.141
## X0023.HK                 -0.144           0.100   0.161   0.201
## X0066.HK  0.121   0.133           0.101                   0.299   0.211
## X0083.HK                           0.284          -0.179
## X0101.HK  0.127          -0.112  -0.112  -0.115          -0.191
## X0144.HK  0.168           0.131                   0.254   0.179
## X0151.HK                  0.111  -0.167   0.240  -0.122
## X0267.HK         -0.105                   0.132   0.208           0.101
## X0291.HK -0.162   0.187  -0.464          -0.415   0.205  -0.119
## X0293.HK  0.175  -0.228                   -0.168   0.184
## X0322.HK -0.160           0.152   0.212  -0.293   0.337           0.115
```

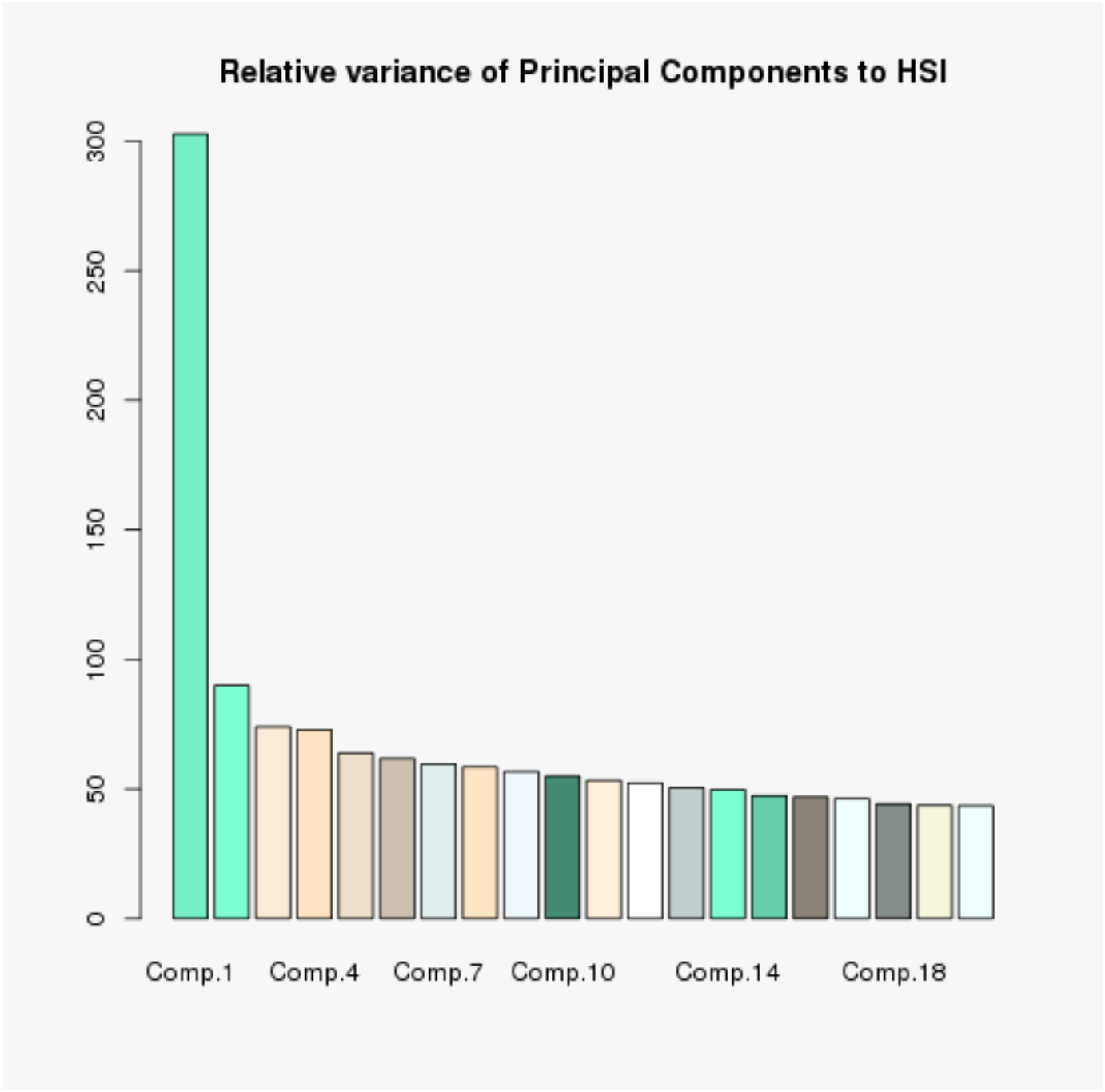
```
## X0330.HK          0.242   0.108   0.156                  -0.133  -0.128
## X0386.HK  0.110                  -0.160                           0.176
## X0388.HK                  0.121                                   0.158
## X0494.HK  0.552  -0.167  -0.335                   0.104          -0.192
## X0688.HK -0.336   0.110  -0.138           0.185
## X0700.HK  0.107                           0.258   0.163   0.141
## X0762.HK                          0.288   0.149          -0.458  -0.183
## X0836.HK         -0.311           0.154          -0.146   0.216
## X0857.HK  0.133          -0.107  -0.109           0.134           0.300
## X0883.HK                                          0.107           0.114
## X0939.HK                                  -0.240                  -0.231
## X0941.HK          0.214  -0.168   0.192   0.105   0.148   0.106  -0.319
## X1044.HK  0.310   0.115  -0.213   0.142          -0.555           0.213
## X1088.HK                          -0.175   0.146
## X1109.HK -0.313          -0.236           0.192
## X1199.HK                  0.213                                   0.242   0.104
## X1299.HK  0.102   0.295   0.227  -0.147          -0.120  -0.157
## X1398.HK -0.111                           -0.236                  -0.109
## X1880.HK                          -0.399   0.120                  -0.280
## X1898.HK         -0.114           -0.134
## X2318.HK         -0.168                           -0.102  -0.101
## X2388.HK                  0.117  -0.107  -0.129                  -0.156
## X2600.HK -0.136                                                  -0.159   0.218
## X2628.HK                                                          0.107   0.296
## X3328.HK                                  -0.140  -0.196   0.106
## X3988.HK                          0.122  -0.266           0.175  -0.170
##          Comp.18 Comp.19 Comp.20 Comp.21 Comp.22 Comp.23 Comp.24 Comp.25
## X0001.HK                  0.107                    0.140           0.150
## X0002.HK  0.168                                                    0.152
## X0003.HK -0.419   0.204  -0.109  -0.160   0.227                    0.191
## X0004.HK  0.146                  -0.141  -0.165   0.136  -0.213
## X0005.HK -0.123          -0.157           0.209   0.249  -0.137
## X0006.HK -0.115                                   0.127          -0.159
## X0011.HK -0.107   0.164   0.160                  -0.157          -0.210
## X0012.HK                          0.102
## X0013.HK                  0.109           -0.162   0.167           0.323
## X0016.HK                          0.150                    0.165
## X0017.HK                 -0.130                   -0.191
## X0019.HK          0.119  -0.323   0.123  -0.112           0.262  -0.109
## X0023.HK          0.213           0.132   0.158   0.114          -0.267
## X0066.HK  0.329  -0.140  -0.155  -0.132           -0.276
## X0083.HK                          0.121   0.176           0.136  -0.140
## X0101.HK -0.130  -0.288   0.265                   -0.170          -0.360
## X0144.HK          0.355           0.162  -0.150  -0.101  -0.115  -0.115
## X0151.HK          0.108   0.258                           -0.181  -0.190
## X0267.HK                 -0.115           0.199           0.181
## X0291.HK  0.176   0.193          -0.337  -0.115   0.173   0.124
## X0293.HK -0.358                           0.170          -0.465
## X0322.HK         -0.227  -0.111   0.125
## X0330.HK -0.133  -0.148   0.124                   0.125   0.185
## X0386.HK                                  -0.114  -0.273
## X0388.HK                          -0.221                  -0.146   0.195
## X0494.HK                 -0.161
## X0688.HK -0.126          -0.119   0.113           -0.163          0.230
## X0700.HK -0.315  -0.191   0.190  -0.375  -0.103  -0.126   0.418
## X0762.HK          0.277           -0.279   0.178
## X0836.HK                          -0.172
```

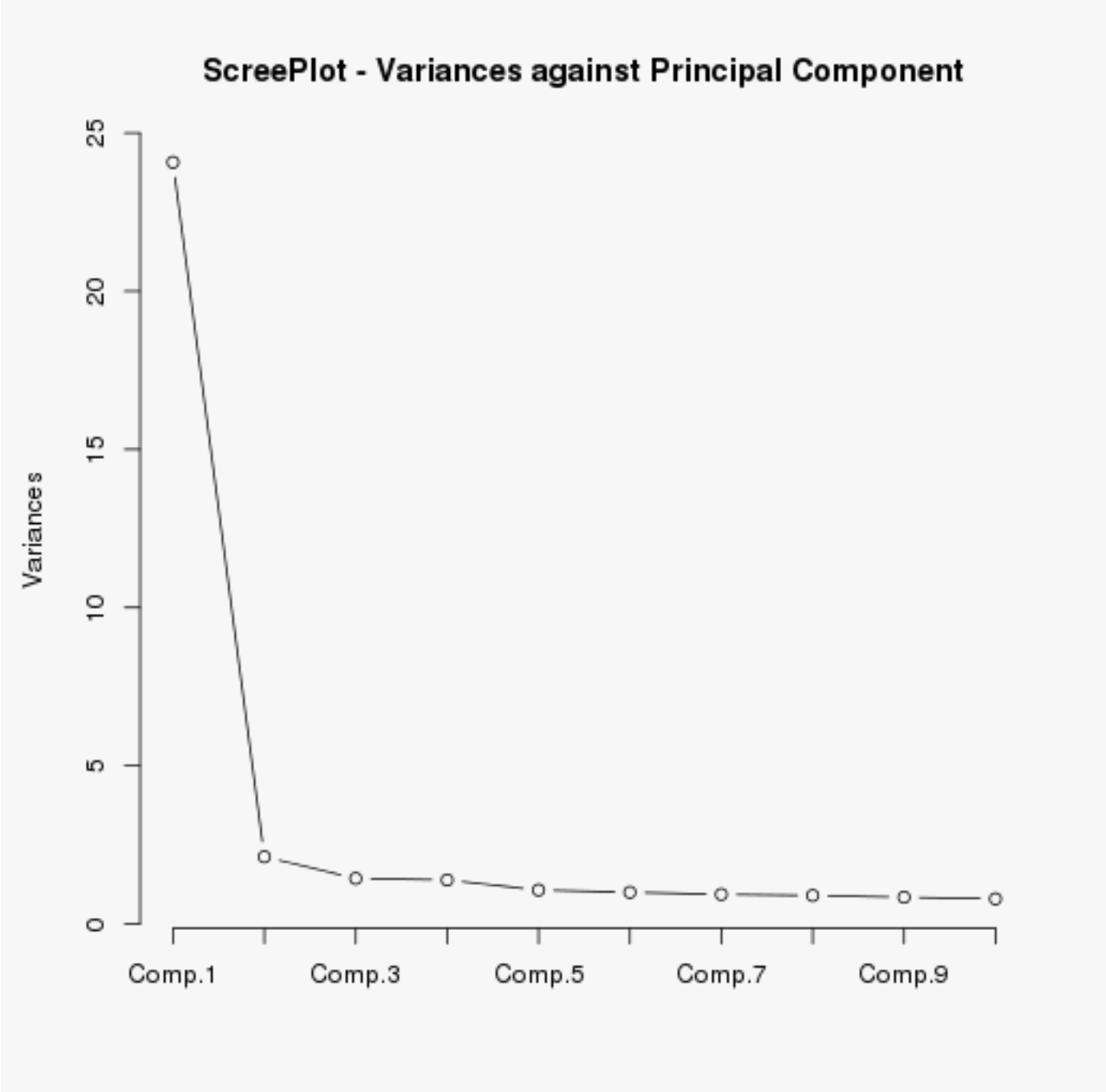
```
## X0857.HK                  0.121   0.244   0.132                   0.121
## X0883.HK                  0.112   0.195   0.284   0.264   0.202   0.219
## X0939.HK                                          -0.116
## X0941.HK         -0.225  -0.179   0.157  -0.336           -0.215
## X1044.HK                          0.150                           0.118
## X1088.HK          0.124   0.314   0.171                   -0.122
## X1109.HK -0.132           -0.124                  -0.155  -0.120   0.178
## X1199.HK  0.169   0.143  -0.175                   0.125
## X1299.HK                  -0.332          -0.363   0.187   0.143  -0.105
## X1398.HK
## X1880.HK  0.370  -0.324  -0.151           0.424
## X1898.HK                  0.152   0.224                   0.125   0.160
## X2318.HK -0.129  -0.147          -0.168           0.235
## X2388.HK          0.118   0.178  -0.144  -0.124           -0.152   0.317
## X2600.HK          0.163  -0.105                  -0.425           -0.175
## X2628.HK -0.127  -0.278  -0.167  -0.192           0.209  -0.218  -0.102
## X3328.HK                                  0.123
## X3988.HK                  0.111
##          Comp.26 Comp.27 Comp.28 Comp.29 Comp.30 Comp.31 Comp.32 Comp.33
## X0001.HK                  -0.106   0.129                           -0.159
## X0002.HK                   0.133          -0.356           -0.224   0.274
## X0003.HK           0.154                                   -0.212
## X0004.HK  0.220    0.265                   0.309  -0.201           0.119
## X0005.HK         -0.242   0.157   0.145  -0.298           -0.133
## X0006.HK                  -0.153           0.261           0.143  -0.165
## X0011.HK -0.112            0.130           0.323   0.196  -0.297
## X0012.HK -0.128           -0.276   0.230  -0.110           -0.248
## X0013.HK         -0.169  -0.244   0.243  -0.122           0.278
## X0016.HK                                                  -0.165          -0.337
## X0017.HK         -0.146   0.262  -0.251                   0.429   0.148
## X0019.HK  0.168            0.204          -0.191
## X0023.HK  0.175            0.152                           0.267
## X0066.HK                  -0.318  -0.124  -0.153   0.126   0.118
## X0083.HK -0.114  -0.219           -0.131           0.245
## X0101.HK           0.281   0.172          -0.229  -0.147   0.132
## X0144.HK -0.297    0.166            0.318           0.152           0.166
## X0151.HK  0.219           -0.157  -0.312                   -0.128
## X0267.HK -0.445    0.363  -0.135  -0.227   0.158           0.121   0.119
## X0291.HK         -0.181           -0.101
## X0293.HK                  -0.284  -0.234
## X0322.HK                           0.172                           -0.188
## X0330.HK  0.147                    0.207           0.114           -0.109
## X0386.HK         -0.117  -0.104           0.147   0.250           -0.198
## X0388.HK                           0.145   0.214           -0.103
## X0494.HK                                                   -0.132
## X0688.HK                           -0.150           0.123
## X0700.HK         -0.118   0.125
## X0762.HK                                                    0.252  -0.268
## X0836.HK                  0.183                   -0.165  -0.119   0.128
## X0857.HK  0.229           0.145  -0.124   0.107
## X0883.HK  0.216   0.118                                           0.287
## X0939.HK          0.176  -0.108                                   0.120
## X0941.HK         -0.105   0.186           0.192  -0.198           0.132
## X1044.HK -0.126   0.104            0.136          -0.132   0.175
## X1088.HK -0.230  -0.101                   -0.316   0.128   0.202
## X1109.HK                           -0.135   0.138           -0.107
## X1199.HK           0.278          -0.152  -0.205  -0.223  -0.144  -0.353
```

```
## X1299.HK                 -0.193  -0.206                          0.129
## X1398.HK                 -0.107
## X1880.HK                          0.135
## X1898.HK -0.312  -0.244  -0.159  -0.258          -0.441
## X2318.HK -0.115   0.158           0.110           0.104
## X2388.HK                  0.282                          -0.188  -0.337
## X2600.HK  0.156  -0.286           0.213          -0.373           0.127
## X2628.HK -0.286  -0.124   0.187                   0.102
## X3328.HK                          0.106                           0.187
## X3988.HK          0.139                           0.117   0.112
##          Comp.34 Comp.35 Comp.36 Comp.37 Comp.38 Comp.39 Comp.40 Comp.41
## X0001.HK  0.146  -0.133                   0.242  -0.179           0.331
## X0002.HK           0.107          -0.149   0.138  -0.185
## X0003.HK           0.181  -0.112
## X0004.HK -0.325           -0.239           0.190   0.261   0.112
## X0005.HK -0.300  -0.387   0.299   0.191   0.191                   -0.161
## X0006.HK         -0.188
## X0011.HK  0.142  -0.292  -0.218   0.109                   -0.345
## X0012.HK         -0.167   0.122  -0.311  -0.207                   -0.266
## X0013.HK                  0.111   0.141                   -0.298
## X0016.HK  0.146           -0.129                  -0.128   0.316
## X0017.HK  0.111  -0.105           -0.251                  -0.140  -0.156
## X0019.HK                  -0.123   0.118
## X0023.HK           0.198   0.266  -0.313          -0.186           -0.106
## X0066.HK  0.104                   0.148           0.292           -0.155
## X0083.HK -0.261   0.482           0.199           0.128           0.236
## X0101.HK                  0.106   0.347   0.155          -0.103
## X0144.HK  0.232   0.161                   0.278           0.148  -0.193
## X0151.HK  0.123           0.145
## X0267.HK -0.127  -0.239   0.317                                   0.230
## X0291.HK         -0.153
## X0293.HK                  -0.123
## X0322.HK                  -0.102                   0.150
## X0330.HK
## X0386.HK -0.263                   -0.148   0.217  -0.144  -0.197
## X0388.HK -0.220   0.178           0.174  -0.206  -0.472   0.102  -0.209
## X0494.HK
## X0688.HK                  -0.126   0.111   0.192          -0.142
## X0700.HK                  -0.103                           0.134  -0.142
## X0762.HK  0.165           -0.119   0.124   0.116
## X0836.HK
## X0857.HK                  0.133                    0.131   0.123  -0.231
## X0883.HK  0.246           -0.145   0.249  -0.123                   0.110
## X0939.HK -0.157  -0.109           0.231  -0.159  -0.127           0.150
## X0941.HK                          0.121  -0.174          -0.127
## X1044.HK
## X1088.HK -0.237           -0.278          -0.448   0.119   0.159   0.143
## X1109.HK                                                          -0.134
## X1199.HK                  -0.101  -0.118  -0.193          -0.407   0.108
## X1299.HK                                                   0.223
## X1398.HK                          -0.124                   0.159  -0.135
## X1880.HK
## X1898.HK           0.132  -0.106   0.124   0.234                   -0.284
## X2318.HK  0.179   0.349   0.212           -0.148   0.254  -0.288  -0.177
## X2388.HK                  0.268                    0.365   0.172   0.189
## X2600.HK  0.226           0.221           -0.175                   0.302
## X2628.HK  0.351           -0.153                  -0.222   0.160   0.141
```

```
## X3328.HK -0.101  -0.102  -0.286  -0.358   0.261   0.137  -0.166   0.213
## X3988.HK                                          -0.156
##          Comp.42 Comp.43 Comp.44 Comp.45 Comp.46 Comp.47 Comp.48
## X0001.HK  0.180           0.370           0.121  -0.503  -0.121
## X0002.HK          0.194
## X0003.HK
## X0004.HK          0.161  -0.180
## X0005.HK  0.149   0.150
## X0006.HK         -0.162
## X0011.HK -0.134   0.200                   0.107
## X0012.HK         -0.277  -0.180  -0.292
## X0013.HK -0.257                                   0.409
## X0016.HK          0.277  -0.123   0.360           0.408   0.271
## X0017.HK  0.116
## X0019.HK -0.133                  -0.135
## X0023.HK  0.152          -0.108  -0.169                   0.138
## X0066.HK  0.122
## X0083.HK -0.176                                           -0.125
## X0101.HK  0.105  -0.223
## X0144.HK
## X0151.HK
## X0267.HK                          0.102  -0.138
## X0291.HK
## X0293.HK
## X0322.HK
## X0330.HK
## X0386.HK  0.245          -0.337
## X0388.HK  0.143  -0.277   0.250   0.116  -0.225
## X0494.HK
## X0688.HK  0.144                  -0.291  -0.506           0.160
## X0700.HK         -0.128
## X0762.HK
## X0836.HK
## X0857.HK -0.399   0.107   0.431
## X0883.HK  0.229  -0.284  -0.314   0.119
## X0939.HK          0.192          -0.393   0.407           0.394
## X0941.HK                          0.120                  -0.127
## X1044.HK          0.114
## X1088.HK  0.169                                   -0.105
## X1109.HK -0.165  -0.160           0.295   0.528          -0.136
## X1199.HK                         -0.131
## X1299.HK         -0.104
## X1398.HK  0.227   0.171   0.106  -0.106           0.280  -0.722
## X1880.HK -0.102   0.109
## X1898.HK                                  0.117  -0.144
## X2318.HK  0.271   0.260   0.166   0.187          -0.101   0.166
## X2388.HK         -0.156  -0.141
## X2600.HK
## X2628.HK -0.129          -0.174  -0.287
## X3328.HK         -0.342   0.255   0.257           0.230   0.221
## X3988.HK -0.405   0.213  -0.298   0.309  -0.341  -0.373
##
##                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  0.187   0.208   0.229   0.250   0.271   0.292   0.312
##                Comp.16 Comp.17 Comp.18 Comp.19 Comp.20 Comp.21 Comp.22
## SS loadings      1.000   1.000   1.000   1.000   1.000   1.000   1.000
## Proportion Var   0.021   0.021   0.021   0.021   0.021   0.021   0.021
## Cumulative Var   0.333   0.354   0.375   0.396   0.417   0.437   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   0.687   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   0.937   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

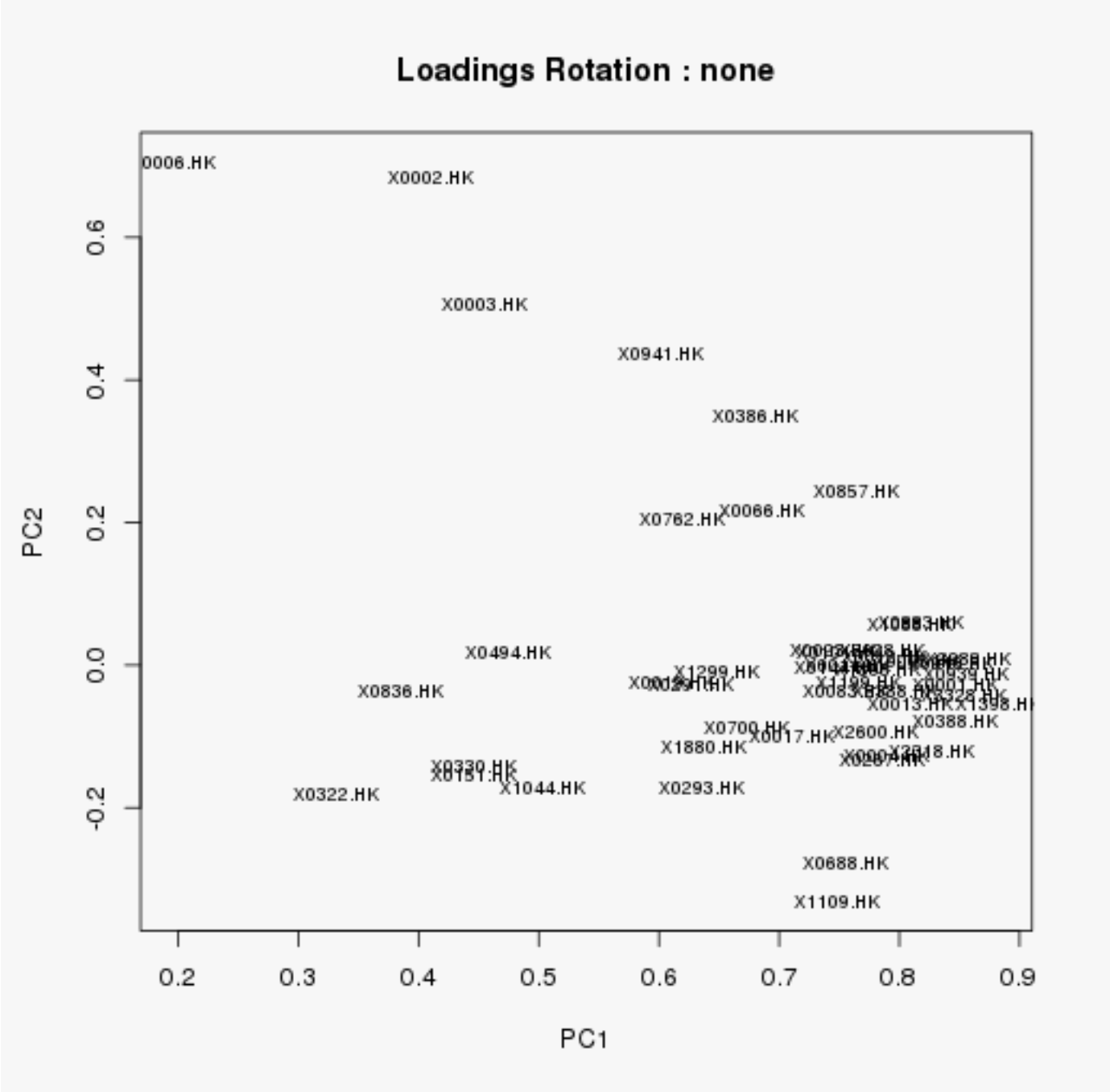
5.2.1 Rotation : none

```
## 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
## X1398.HK   40 0.88 -0.05  0.06 -0.14 -0.06 0.81 0.19
## X3988.HK   48 0.86  0.01  0.06 -0.10  0.01 0.75 0.25
## X0939.HK   33 0.86 -0.01  0.11 -0.11  0.00 0.76 0.24
## X3328.HK   47 0.85 -0.04  0.02 -0.17  0.03 0.76 0.24
## X0001.HK    1 0.85 -0.03 -0.20  0.18 -0.06 0.80 0.20
## X0388.HK   25 0.85 -0.08 -0.08  0.06 -0.04 0.73 0.27
## X0016.HK   10 0.84  0.00 -0.20  0.10 -0.09 0.77 0.23
## X2318.HK   43 0.83 -0.12  0.01 -0.13 -0.06 0.72 0.28
## X0883.HK   32 0.82  0.06  0.10 -0.17 -0.03 0.71 0.29
## X0005.HK    5 0.81  0.01  0.01 -0.11 -0.02 0.68 0.32
## X0013.HK    9 0.81 -0.05 -0.15  0.16 -0.04 0.71 0.29
## X1088.HK   36 0.81  0.06  0.12 -0.09  0.07 0.69 0.31
## X2388.HK   44 0.80 -0.04  0.00  0.07 -0.13 0.66 0.34
## X0004.HK    4 0.79 -0.13 -0.16  0.06 -0.05 0.67 0.33
## X0012.HK    8 0.79  0.01 -0.21  0.13 -0.01 0.68 0.32
## X2628.HK   46 0.79  0.02  0.05 -0.13 -0.01 0.64 0.36
## X0267.HK   19 0.79 -0.13  0.07  0.06  0.10 0.65 0.35
## X1898.HK   42 0.78 -0.01  0.03 -0.12 -0.01 0.63 0.37
## X2600.HK   45 0.78 -0.09  0.01 -0.18 -0.04 0.65 0.35
## X1199.HK   38 0.77 -0.02 -0.03 -0.26  0.05 0.66 0.34
## X0857.HK   31 0.76  0.24  0.10 -0.19  0.12 0.70 0.30
## X0011.HK    7 0.76  0.00 -0.18  0.27 -0.11 0.69 0.31
## X0083.HK   15 0.76 -0.04 -0.27  0.07 -0.04 0.65 0.35
## X0688.HK   27 0.75 -0.28 -0.02 -0.16 -0.07 0.68 0.32
## X0101.HK   16 0.75  0.02 -0.24  0.05  0.03 0.62 0.38
## X1109.HK   37 0.75 -0.33 -0.03 -0.12  0.02 0.69 0.31
## X0144.HK   17 0.75  0.00  0.05 -0.13  0.10 0.59 0.41
## X0023.HK   13 0.75  0.02 -0.02  0.15 -0.19 0.61 0.39
## X0017.HK   11 0.71 -0.10 -0.27  0.07  0.04 0.60 0.40
## X0066.HK   14 0.69  0.22 -0.09  0.24  0.02 0.58 0.42
## X0386.HK   24 0.68  0.35  0.14 -0.21  0.22 0.70 0.30
## X0700.HK   28 0.67 -0.09  0.16 -0.10 -0.26 0.56 0.44
## X1299.HK   39 0.65 -0.01  0.00  0.06  0.04 0.43 0.57
## X1880.HK   41 0.64 -0.12  0.14 -0.08 -0.08 0.45 0.55
## X0293.HK   21 0.64 -0.17 -0.09  0.13 -0.04 0.46 0.54
## X0291.HK   20 0.63 -0.03 -0.07  0.04  0.00 0.40 0.60
## X0762.HK   29 0.62  0.20  0.31 -0.17  0.09 0.56 0.44
## X0019.HK   12 0.61 -0.02 -0.01  0.34  0.04 0.49 0.51
## X0941.HK   34 0.60  0.44  0.16 -0.03  0.07 0.58 0.42
## X1044.HK   35 0.50 -0.17  0.39  0.20 -0.20 0.51 0.49
## X0494.HK   26 0.47  0.02  0.03 -0.13 -0.07 0.25 0.75
## X0330.HK   23 0.45 -0.14 -0.03 -0.06  0.44 0.42 0.58
## X0006.HK    6 0.20  0.71 -0.02 -0.09 -0.14 0.57 0.43
## X0002.HK    2 0.41  0.68  0.02  0.16 -0.17 0.69 0.31
## X0003.HK    3 0.46  0.51 -0.03  0.34  0.13 0.60 0.40
## X0151.HK   18 0.45 -0.16  0.56  0.28  0.13 0.64 0.36
## X0322.HK   22 0.33 -0.18  0.51  0.48  0.00 0.63 0.37
## X0836.HK   30 0.39 -0.04 -0.12  0.17  0.68 0.66 0.34
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    24.07 2.12 1.44 1.39 1.07
```

```
## Proportion Var  0.50 0.04 0.03 0.03 0.02
## Cumulative Var  0.50 0.55 0.58 0.60 0.63
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  41.11 0.3
## The degrees of freedom for the model are 898  and the objective function was  6.47
##  0.3The number of observations was  311  with Chi Square =  1875  with prob <  4.1e-71
##  0.3
## Fit based upon off diagonal values = 0.99


##              PC1        PC2
## X0001.HK 0.8470 -0.0270931
## X0002.HK 0.4107  0.6847039
## X0003.HK 0.4556  0.5061185
## X0004.HK 0.7888 -0.1268691
## X0005.HK 0.8140  0.0051068
## X0006.HK 0.1962  0.7056289
## X0011.HK 0.7566 -0.0006383
## X0012.HK 0.7873  0.0126118
## X0013.HK 0.8095 -0.0531362
## X0016.HK 0.8438  0.0034188
## X0017.HK 0.7105 -0.0983431
## X0019.HK 0.6099 -0.0229067
## X0023.HK 0.7454  0.0221132
## X0066.HK 0.6854  0.2157397
## X0083.HK 0.7560 -0.0353666
## X0101.HK 0.7492  0.0167056
## X0144.HK 0.7477 -0.0037675
## X0151.HK 0.4458 -0.1554312
## X0267.HK 0.7851 -0.1338092
## X0291.HK 0.6259 -0.0266267
## X0293.HK 0.6359 -0.1729196
## X0322.HK 0.3312 -0.1808705
## X0330.HK 0.4461 -0.1404710
## X0386.HK 0.6793  0.3487265
## X0388.HK 0.8457 -0.0788502
## X0494.HK 0.4739  0.0172768
## X0688.HK 0.7545 -0.2773207
## X0700.HK 0.6722 -0.0869588
## X0762.HK 0.6191  0.2042328
## X0836.HK 0.3859 -0.0361670
## X0857.HK 0.7646  0.2428152
## X0883.HK 0.8179  0.0610982
## X0939.HK 0.8557 -0.0127088
## X0941.HK 0.6020  0.4376477
## X1044.HK 0.5028 -0.1712557
## X1088.HK 0.8091  0.0581286
## X1109.HK 0.7489 -0.3311717
## X1199.HK 0.7658 -0.0230547
## X1299.HK 0.6476 -0.0079834
## X1398.HK 0.8830 -0.0547920
## X1880.HK 0.6373 -0.1156912
## X1898.HK 0.7827 -0.0063552
## X2318.HK 0.8261 -0.1205348
## X2388.HK 0.7967 -0.0371692
## X2600.HK 0.7797 -0.0935673
```

```
## X2628.HK 0.7862  0.0215040
## X3328.HK 0.8541 -0.0424729
## X3988.HK 0.8576  0.0075686
```



5.2.2 Rotation : varimax

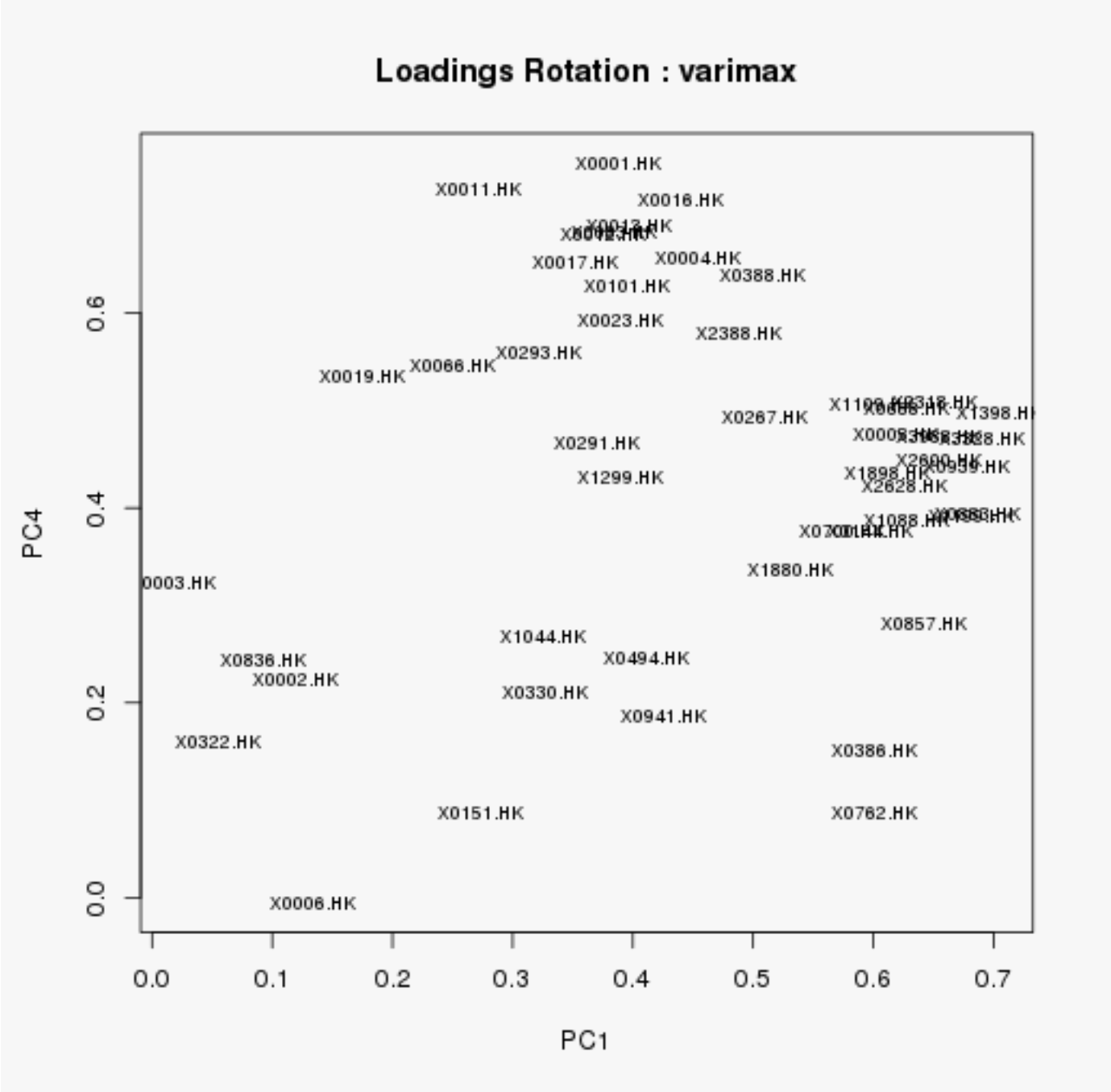
Varimax rotation is an orthogonal rotation of the factor axes to maximize the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix, which has the effect of differentiating the original variables by extracted factor. Each factor will tend to have either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

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "varimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##          item  PC1   PC4   PC2   PC3   PC5   h2   u2
## X1398.HK   40 0.71  0.50  0.15  0.19  0.08 0.81 0.19
## X3328.HK   47 0.69  0.47  0.14  0.12  0.16 0.76 0.24
## X0883.HK   32 0.69  0.39  0.24  0.15  0.09 0.71 0.29
## X1199.HK   38 0.68  0.39  0.12  0.01  0.16 0.66 0.34
## X0939.HK   33 0.68  0.44  0.19  0.22  0.13 0.76 0.24
## X3988.HK   48 0.65  0.47  0.20  0.18  0.15 0.75 0.25
## X2600.HK   45 0.65  0.45  0.07  0.10  0.08 0.65 0.35
## X2318.HK   43 0.65  0.51  0.07  0.15  0.08 0.72 0.28
## X0857.HK   31 0.64  0.28  0.39  0.09  0.22 0.70 0.30
## X0688.HK   27 0.63  0.50 -0.10  0.13  0.06 0.68 0.32
## X1088.HK   36 0.63  0.39  0.25  0.22  0.19 0.69 0.31
## X2628.HK   46 0.63  0.42  0.19  0.14  0.11 0.64 0.36
## X0005.HK    5 0.62  0.48  0.19  0.13  0.12 0.68 0.32
## X1898.HK   42 0.61  0.44  0.17  0.14  0.12 0.63 0.37
## X0386.HK   24 0.60  0.15  0.47  0.07  0.29 0.70 0.30
## X0762.HK   29 0.60  0.09  0.34  0.24  0.14 0.56 0.44
## X1109.HK   37 0.60  0.51 -0.15  0.15  0.15 0.69 0.31
## X0144.HK   17 0.60  0.38  0.16  0.13  0.22 0.59 0.41
## X0700.HK   28 0.57  0.38  0.08  0.24 -0.16 0.56 0.44
## X1880.HK   41 0.53  0.34  0.04  0.23  0.02 0.45 0.55
## X0267.HK   19 0.51  0.49  0.08  0.30  0.24 0.65 0.35
## X0494.HK   26 0.41  0.25  0.12  0.06  0.00 0.25 0.75
## X0001.HK    1 0.39  0.75  0.20  0.15  0.13 0.80 0.20
## X0011.HK    7 0.27  0.73  0.22  0.19  0.07 0.69 0.31
## X0016.HK   10 0.44  0.72  0.21  0.09  0.09 0.77 0.23
## X0013.HK    9 0.40  0.69  0.16  0.17  0.13 0.71 0.29
## X0083.HK   15 0.38  0.68  0.14  0.02  0.13 0.65 0.35
## X0012.HK    8 0.38  0.68  0.21  0.09  0.16 0.68 0.32
## X0004.HK    4 0.45  0.66  0.07  0.12  0.12 0.67 0.33
## X0017.HK   11 0.35  0.65  0.07  0.02  0.21 0.60 0.40
## X0388.HK   25 0.51  0.64  0.14  0.18  0.12 0.73 0.27
## X0101.HK   16 0.39  0.63  0.19  0.02  0.19 0.62 0.38
## X0023.HK   13 0.39  0.59  0.23  0.24 -0.03 0.61 0.39
## X2388.HK   44 0.49  0.58  0.17  0.23  0.02 0.66 0.34
## X0293.HK   21 0.32  0.56  0.01  0.19  0.10 0.46 0.54
## X0066.HK   14 0.25  0.55  0.40  0.17  0.17 0.58 0.42
## X0019.HK   12 0.17  0.53  0.18  0.33  0.18 0.49 0.51
## X0291.HK   20 0.37  0.47  0.13  0.12  0.13 0.40 0.60
## X1299.HK   39 0.39  0.43  0.16  0.19  0.16 0.43 0.57
## X0002.HK    2 0.12  0.22  0.78  0.06 -0.09 0.69 0.31
## X0006.HK    6 0.13 -0.01  0.71 -0.17 -0.13 0.57 0.43
## X0003.HK    3 0.02  0.32  0.64  0.17  0.23 0.60 0.40
## X0941.HK   34 0.43  0.19  0.57  0.15  0.14 0.58 0.42
## X0322.HK   22 0.06  0.16  0.02  0.77  0.06 0.63 0.37
## X0151.HK   18 0.27  0.09  0.04  0.72  0.18 0.64 0.36
## X1044.HK   35 0.32  0.27  0.02  0.57 -0.12 0.51 0.49
```

```
## X0836.HK   30 0.09  0.24  0.06  0.08  0.76 0.66 0.34
## X0330.HK   23 0.33  0.21 -0.05  0.06  0.51 0.42 0.58
##
##                  PC1   PC4  PC2  PC3  PC5
## SS loadings    11.48 10.78 3.40 2.64 1.80
## Proportion Var  0.24  0.22 0.07 0.06 0.04
## Cumulative Var  0.24  0.46 0.53 0.59 0.63
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  41.11 0.3
## The degrees of freedom for the model are 898  and the objective function was  6.47
##  0.3The number of observations was  311  with Chi Square =  1875  with prob <  4.1e-71
##  0.3
## Fit based upon off diagonal values = 0.99
```

```
##               PC1       PC4
## X0001.HK 0.38739  0.754221
## X0002.HK 0.11868  0.224672
## X0003.HK 0.01809  0.322920
## X0004.HK 0.45321  0.656722
## X0005.HK 0.61937  0.475893
## X0006.HK 0.13294 -0.005283
## X0011.HK 0.27101  0.726519
## X0012.HK 0.37584  0.681524
## X0013.HK 0.39668  0.689272
## X0016.HK 0.44053  0.717026
## X0017.HK 0.35238  0.651522
## X0019.HK 0.17500  0.534193
## X0023.HK 0.39033  0.592234
## X0066.HK 0.25090  0.545549
## X0083.HK 0.38369  0.683327
## X0101.HK 0.39418  0.627813
## X0144.HK 0.59744  0.376228
## X0151.HK 0.27345  0.087674
## X0267.HK 0.50957  0.492346
## X0291.HK 0.36977  0.465854
## X0293.HK 0.32186  0.559099
## X0322.HK 0.05514  0.160351
## X0330.HK 0.32757  0.211541
## X0386.HK 0.60157  0.151143
## X0388.HK 0.50810  0.638307
## X0494.HK 0.41125  0.246385
## X0688.HK 0.62800  0.501394
## X0700.HK 0.57471  0.375767
## X0762.HK 0.60101  0.088045
## X0836.HK 0.09303  0.242788
## X0857.HK 0.64265  0.282081
## X0883.HK 0.68599  0.393442
## X0939.HK 0.67766  0.442932
## X0941.HK 0.42572  0.186651
## X1044.HK 0.32432  0.267716
## X1088.HK 0.62700  0.386413
## X1109.HK 0.59919  0.506435
## X1199.HK 0.68154  0.391275
## X1299.HK 0.39024  0.432242
## X1398.HK 0.70535  0.497402
```

```
## X1880.HK 0.53143  0.336095
## X1898.HK 0.61147  0.436549
## X2318.HK 0.65181  0.508003
## X2388.HK 0.48719  0.579196
## X2600.HK 0.65400  0.448146
## X2628.HK 0.62615  0.421655
## X3328.HK 0.69088  0.471352
## X3988.HK 0.65431  0.473734
```



5.2.3 Rotation : quatimax

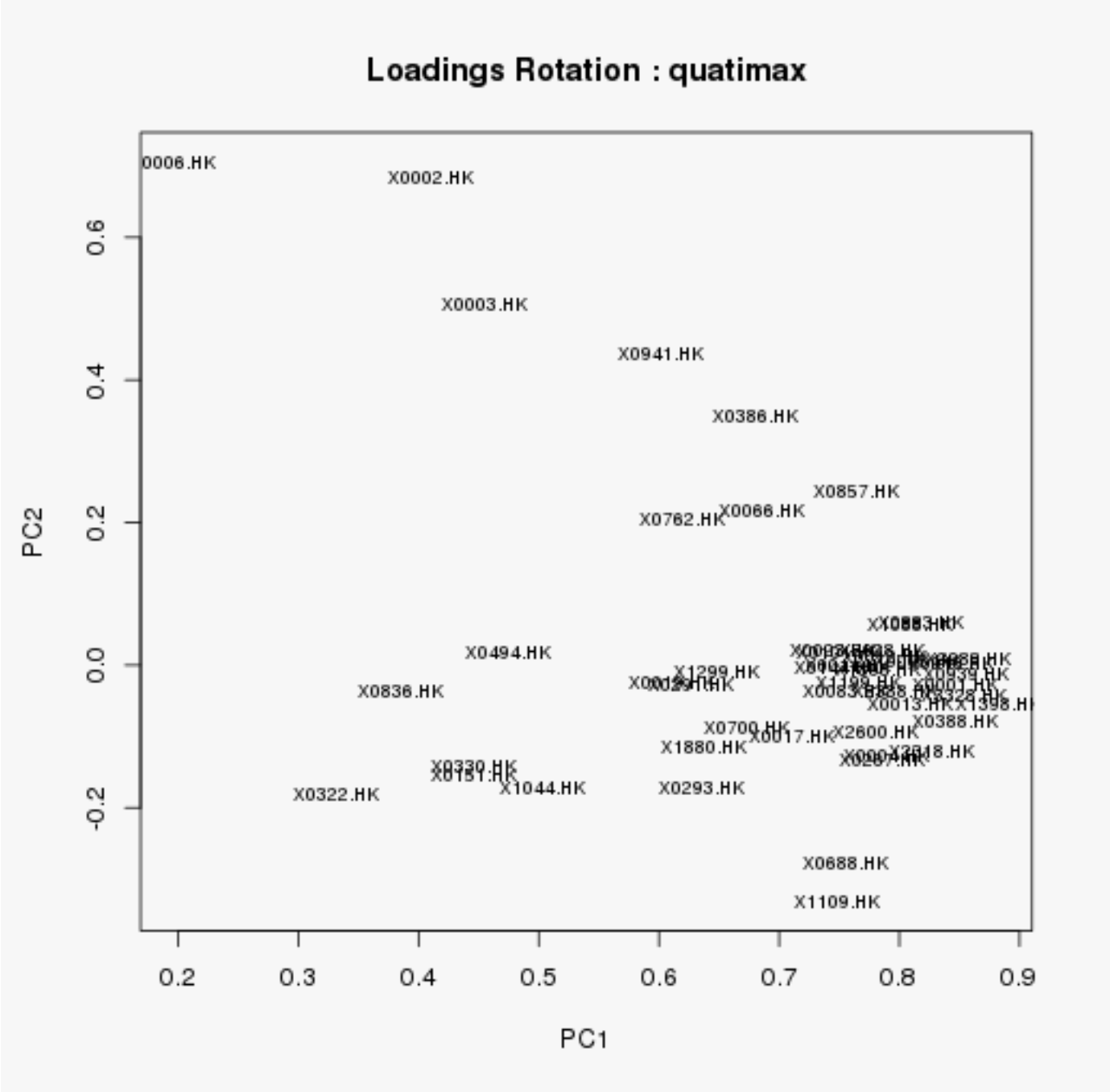
Quartimax rotation is an orthogonal alternative which minimizes the number of factors needed to explain each variable. This type of rotation often generates a general factor on which most variables are loaded to a high or medium degree. Such a factor structure is usually not helpful to the research purpose.

```
## 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
## X1398.HK   40 0.88 -0.05  0.06 -0.14 -0.06 0.81 0.19
## X3988.HK   48 0.86  0.01  0.06 -0.10  0.01 0.75 0.25
## X0939.HK   33 0.86 -0.01  0.11 -0.11  0.00 0.76 0.24
## X3328.HK   47 0.85 -0.04  0.02 -0.17  0.03 0.76 0.24
## X0001.HK    1 0.85 -0.03 -0.20  0.18 -0.06 0.80 0.20
## X0388.HK   25 0.85 -0.08 -0.08  0.06 -0.04 0.73 0.27
## X0016.HK   10 0.84  0.00 -0.20  0.10 -0.09 0.77 0.23
## X2318.HK   43 0.83 -0.12  0.01 -0.13 -0.06 0.72 0.28
## X0883.HK   32 0.82  0.06  0.10 -0.17 -0.03 0.71 0.29
## X0005.HK    5 0.81  0.01  0.01 -0.11 -0.02 0.68 0.32
## X0013.HK    9 0.81 -0.05 -0.15  0.16 -0.04 0.71 0.29
## X1088.HK   36 0.81  0.06  0.12 -0.09  0.07 0.69 0.31
## X2388.HK   44 0.80 -0.04  0.00  0.07 -0.13 0.66 0.34
## X0004.HK    4 0.79 -0.13 -0.16  0.06 -0.05 0.67 0.33
## X0012.HK    8 0.79  0.01 -0.21  0.13 -0.01 0.68 0.32
## X2628.HK   46 0.79  0.02  0.05 -0.13 -0.01 0.64 0.36
## X0267.HK   19 0.79 -0.13  0.07  0.06  0.10 0.65 0.35
## X1898.HK   42 0.78 -0.01  0.03 -0.12 -0.01 0.63 0.37
## X2600.HK   45 0.78 -0.09  0.01 -0.18 -0.04 0.65 0.35
## X1199.HK   38 0.77 -0.02 -0.03 -0.26  0.05 0.66 0.34
## X0857.HK   31 0.76  0.24  0.10 -0.19  0.12 0.70 0.30
## X0011.HK    7 0.76  0.00 -0.18  0.27 -0.11 0.69 0.31
## X0083.HK   15 0.76 -0.04 -0.27  0.07 -0.04 0.65 0.35
## X0688.HK   27 0.75 -0.28 -0.02 -0.16 -0.07 0.68 0.32
## X0101.HK   16 0.75  0.02 -0.24  0.05  0.03 0.62 0.38
## X1109.HK   37 0.75 -0.33 -0.03 -0.12  0.02 0.69 0.31
## X0144.HK   17 0.75  0.00  0.05 -0.13  0.10 0.59 0.41
## X0023.HK   13 0.75  0.02 -0.02  0.15 -0.19 0.61 0.39
## X0017.HK   11 0.71 -0.10 -0.27  0.07  0.04 0.60 0.40
## X0066.HK   14 0.69  0.22 -0.09  0.24  0.02 0.58 0.42
## X0386.HK   24 0.68  0.35  0.14 -0.21  0.22 0.70 0.30
## X0700.HK   28 0.67 -0.09  0.16 -0.10 -0.26 0.56 0.44
## X1299.HK   39 0.65 -0.01  0.00  0.06  0.04 0.43 0.57
## X1880.HK   41 0.64 -0.12  0.14 -0.08 -0.08 0.45 0.55
## X0293.HK   21 0.64 -0.17 -0.09  0.13 -0.04 0.46 0.54
## X0291.HK   20 0.63 -0.03 -0.07  0.04  0.00 0.40 0.60
## X0762.HK   29 0.62  0.20  0.31 -0.17  0.09 0.56 0.44
## X0019.HK   12 0.61 -0.02 -0.01  0.34  0.04 0.49 0.51
## X0941.HK   34 0.60  0.44  0.16 -0.03  0.07 0.58 0.42
## X1044.HK   35 0.50 -0.17  0.39  0.20 -0.20 0.51 0.49
## X0494.HK   26 0.47  0.02  0.03 -0.13 -0.07 0.25 0.75
## X0330.HK   23 0.45 -0.14 -0.03 -0.06  0.44 0.42 0.58
## X0006.HK    6 0.20  0.71 -0.02 -0.09 -0.14 0.57 0.43
## X0002.HK    2 0.41  0.68  0.02  0.16 -0.17 0.69 0.31
## X0003.HK    3 0.46  0.51 -0.03  0.34  0.13 0.60 0.40
## X0151.HK   18 0.45 -0.16  0.56  0.28  0.13 0.64 0.36
## X0322.HK   22 0.33 -0.18  0.51  0.48  0.00 0.63 0.37
## X0836.HK   30 0.39 -0.04 -0.12  0.17  0.68 0.66 0.34
```

```
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    24.07 2.12 1.44 1.39 1.07
## Proportion Var  0.50 0.04 0.03 0.03 0.02
## Cumulative Var  0.50 0.55 0.58 0.60 0.63
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  41.11 0.3
## The degrees of freedom for the model are 898  and the objective function was  6.47
##  0.3The number of observations was  311  with Chi Square =  1875  with prob <  4.1e-71
##  0.3
## Fit based upon off diagonal values = 0.99
```

```
##              PC1        PC2
## X0001.HK 0.8470 -0.0270931
## X0002.HK 0.4107  0.6847039
## X0003.HK 0.4556  0.5061185
## X0004.HK 0.7888 -0.1268691
## X0005.HK 0.8140  0.0051068
## X0006.HK 0.1962  0.7056289
## X0011.HK 0.7566 -0.0006383
## X0012.HK 0.7873  0.0126118
## X0013.HK 0.8095 -0.0531362
## X0016.HK 0.8438  0.0034188
## X0017.HK 0.7105 -0.0983431
## X0019.HK 0.6099 -0.0229067
## X0023.HK 0.7454  0.0221132
## X0066.HK 0.6854  0.2157397
## X0083.HK 0.7560 -0.0353666
## X0101.HK 0.7492  0.0167056
## X0144.HK 0.7477 -0.0037675
## X0151.HK 0.4458 -0.1554312
## X0267.HK 0.7851 -0.1338092
## X0291.HK 0.6259 -0.0266267
## X0293.HK 0.6359 -0.1729196
## X0322.HK 0.3312 -0.1808705
## X0330.HK 0.4461 -0.1404710
## X0386.HK 0.6793  0.3487265
## X0388.HK 0.8457 -0.0788502
## X0494.HK 0.4739  0.0172768
## X0688.HK 0.7545 -0.2773207
## X0700.HK 0.6722 -0.0869588
## X0762.HK 0.6191  0.2042328
## X0836.HK 0.3859 -0.0361670
## X0857.HK 0.7646  0.2428152
## X0883.HK 0.8179  0.0610982
## X0939.HK 0.8557 -0.0127088
## X0941.HK 0.6020  0.4376477
## X1044.HK 0.5028 -0.1712557
## X1088.HK 0.8091  0.0581286
## X1109.HK 0.7489 -0.3311717
## X1199.HK 0.7658 -0.0230547
## X1299.HK 0.6476 -0.0079834
## X1398.HK 0.8830 -0.0547920
## X1880.HK 0.6373 -0.1156912
## X1898.HK 0.7827 -0.0063552
```

```
## X2318.HK 0.8261 -0.1205348
## X2388.HK 0.7967 -0.0371692
## X2600.HK 0.7797 -0.0935673
## X2628.HK 0.7862  0.0215040
## X3328.HK 0.8541 -0.0424729
## X3988.HK 0.8576  0.0075686
```



5.2.4 Rotation : simplimax

A compromise between Varimax and Quartimax criteria.

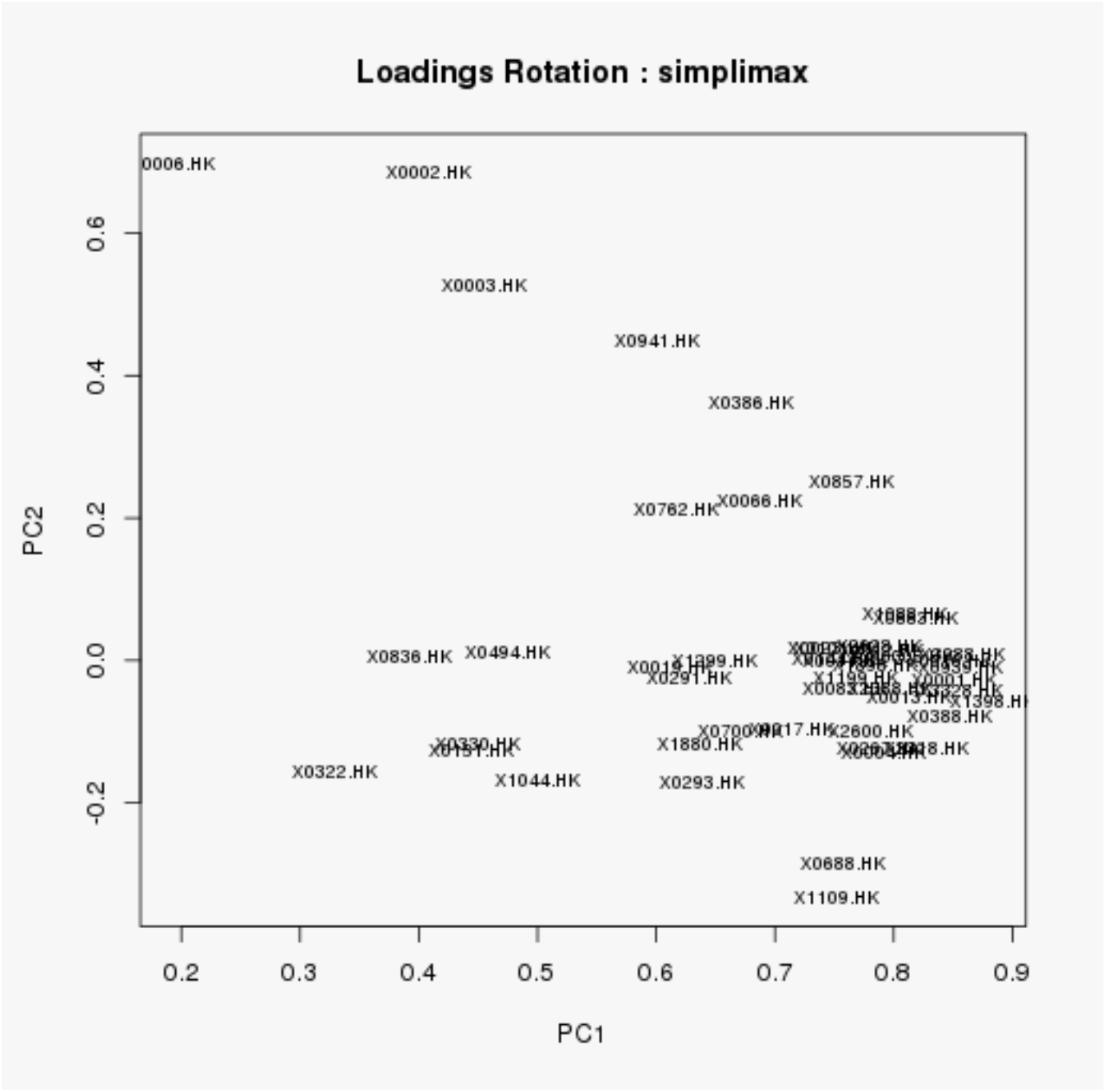
```
## Warning message: convergence not obtained in GPFoblq. 1000 iterations used.

## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "simplimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##          item  PC1   PC2   PC4   PC3   PC5   h2   u2
## X1398.HK   40 0.88 -0.06 -0.09  0.07 -0.05 0.81 0.19
## X3988.HK   48 0.86  0.01 -0.05  0.07  0.02 0.75 0.25
## X0939.HK   33 0.86 -0.01 -0.06  0.12  0.01 0.76 0.24
## X3328.HK   47 0.86 -0.04 -0.11  0.03  0.03 0.76 0.24
## X0001.HK    1 0.85 -0.03  0.23 -0.20 -0.11 0.80 0.20
## X0388.HK   25 0.85 -0.08  0.11 -0.07 -0.07 0.73 0.27
## X0016.HK   10 0.85  0.00  0.14 -0.20 -0.12 0.77 0.23
## X2318.HK   43 0.83 -0.12 -0.08  0.01 -0.06 0.72 0.28
## X0883.HK   32 0.82  0.06 -0.13  0.10 -0.01 0.71 0.29
## X0005.HK    5 0.82  0.00 -0.06  0.01 -0.01 0.68 0.32
## X0013.HK    9 0.81 -0.05  0.20 -0.14 -0.08 0.71 0.29
## X1088.HK   36 0.81  0.07 -0.04  0.14  0.08 0.69 0.31
## X2388.HK   44 0.80 -0.04  0.11  0.00 -0.14 0.66 0.34
## X0004.HK    4 0.79 -0.13  0.10 -0.16 -0.08 0.67 0.33
## X0012.HK    8 0.79  0.01  0.17 -0.21 -0.05 0.68 0.32
## X0267.HK   19 0.79 -0.12  0.12  0.09  0.09 0.65 0.35
## X2628.HK   46 0.79  0.02 -0.09  0.05  0.00 0.64 0.36
## X1898.HK   42 0.78 -0.01 -0.07  0.04  0.00 0.63 0.37
## X2600.HK   45 0.78 -0.10 -0.13  0.01 -0.04 0.65 0.35
## X1199.HK   38 0.77 -0.03 -0.21 -0.02  0.06 0.66 0.34
## X0857.HK   31 0.76  0.25 -0.14  0.12  0.15 0.70 0.30
## X0083.HK   15 0.76 -0.04  0.11 -0.27 -0.08 0.65 0.35
## X0011.HK    7 0.76  0.00  0.31 -0.18 -0.16 0.69 0.31
## X0688.HK   27 0.76 -0.28 -0.11 -0.02 -0.09 0.68 0.32
## X0101.HK   16 0.75  0.02  0.10 -0.23  0.00 0.62 0.38
## X1109.HK   37 0.75 -0.33 -0.06 -0.02  0.00 0.69 0.31
## X0144.HK   17 0.75  0.00 -0.08  0.06  0.11 0.59 0.41
## X0023.HK   13 0.75  0.02  0.18 -0.02 -0.21 0.61 0.39
## X0017.HK   11 0.71 -0.10  0.12 -0.26  0.00 0.60 0.40
## X0066.HK   14 0.69  0.23  0.27 -0.08  0.00 0.58 0.42
## X0386.HK   24 0.68  0.36 -0.17  0.16  0.27 0.70 0.30
## X0700.HK   28 0.67 -0.10 -0.08  0.15 -0.25 0.56 0.44
## X1299.HK   39 0.65  0.00  0.10  0.01  0.03 0.43 0.57
## X0293.HK   21 0.64 -0.17  0.17 -0.09 -0.08 0.46 0.54
## X1880.HK   41 0.64 -0.12 -0.05  0.14 -0.07 0.45 0.55
## X0291.HK   20 0.63 -0.02  0.08 -0.07 -0.01 0.40 0.60
## X0762.HK   29 0.62  0.21 -0.14  0.33  0.14 0.56 0.44
## X0019.HK   12 0.61 -0.01  0.37  0.00  0.01 0.49 0.51
## X0941.HK   34 0.60  0.45  0.00  0.17  0.11 0.58 0.42
## X1044.HK   35 0.50 -0.17  0.22  0.39 -0.20 0.51 0.49
## X0494.HK   26 0.47  0.01 -0.10  0.03 -0.06 0.25 0.75
## X0330.HK   23 0.45 -0.12  0.00 -0.01  0.43 0.42 0.58
## X0006.HK    6 0.19  0.70 -0.11 -0.02 -0.10 0.57 0.43
## X0002.HK    2 0.41  0.68  0.15  0.02 -0.14 0.69 0.31
## X0003.HK    3 0.46  0.53  0.36 -0.01  0.13 0.60 0.40
## X0322.HK   22 0.33 -0.16  0.50  0.52 -0.01 0.63 0.37
## X0151.HK   18 0.44 -0.13  0.32  0.58  0.15 0.64 0.36
## X0836.HK   30 0.39  0.01  0.24 -0.08  0.66 0.66 0.34
```

```
##
##                  PC1  PC2  PC4  PC3  PC5
## SS loadings    24.07 2.13 1.39 1.44 1.07
## Proportion Var  0.50 0.04 0.03 0.03 0.02
## Cumulative Var  0.50 0.55 0.57 0.60 0.63
##
##  With component correlations of
##       PC1   PC2   PC4   PC3   PC5
## PC1  1.00  0.00 -0.06  0.00  0.00
## PC2  0.00  1.00 -0.01 -0.01 -0.11
## PC4 -0.06 -0.01  1.00 -0.01  0.02
## PC3  0.00 -0.01 -0.01  1.00 -0.14
## PC5  0.00 -0.11  0.02 -0.14  1.00
##
## Test of the hypothesis that 5 components are sufficient.
##
## The degrees of freedom for the null model are  1128  and the objective function was  41.11 0.3
## The degrees of freedom for the model are 898  and the objective function was  6.47
##  0.3The number of observations was  311  with Chi Square =  1875  with prob <  4.1e-71
##  0.3
## Fit based upon off diagonal values = 0.99

##             PC1        PC2
## X0001.HK 0.8498 -0.0263534
## X0002.HK 0.4077  0.6848190
## X0003.HK 0.4556  0.5265781
## X0004.HK 0.7916 -0.1286603
## X0005.HK 0.8152  0.0043611
## X0006.HK 0.1932  0.6983255
## X0011.HK 0.7587  0.0002508
## X0012.HK 0.7903  0.0142703
## X0013.HK 0.8121 -0.0511344
## X0016.HK 0.8464  0.0004554
## X0017.HK 0.7145 -0.0970026
## X0019.HK 0.6115 -0.0088822
## X0023.HK 0.7457  0.0186119
## X0066.HK 0.6867  0.2254443
## X0083.HK 0.7594 -0.0382325
## X0101.HK 0.7525  0.0179961
## X0144.HK 0.7492  0.0021591
## X0151.HK 0.4435 -0.1276925
## X0267.HK 0.7870 -0.1223871
## X0291.HK 0.6277 -0.0244414
## X0293.HK 0.6382 -0.1715235
## X0322.HK 0.3286 -0.1563806
## X0330.HK 0.4503 -0.1174414
## X0386.HK 0.6792  0.3619180
## X0388.HK 0.8479 -0.0781946
## X0494.HK 0.4740  0.0124162
## X0688.HK 0.7565 -0.2845307
## X0700.HK 0.6708 -0.0988385
## X0762.HK 0.6174  0.2137678
## X0836.HK 0.3918  0.0053392
## X0857.HK 0.7648  0.2500445
## X0883.HK 0.8181  0.0597832
## X0939.HK 0.8562 -0.0104102
## X0941.HK 0.6005  0.4480755
```

```
## X1044.HK 0.5001 -0.1673086
## X1088.HK 0.8096  0.0653249
## X1109.HK 0.7518 -0.3324374
## X1199.HK 0.7676 -0.0256272
## X1299.HK 0.6490 -0.0013364
## X1398.HK 0.8838 -0.0572922
## X1880.HK 0.6372 -0.1174735
## X1898.HK 0.7837 -0.0062379
## X2318.HK 0.8275 -0.1244928
## X2388.HK 0.7975 -0.0392937
## X2600.HK 0.7810 -0.0982928
## X2628.HK 0.7870  0.0211548
## X3328.HK 0.8557 -0.0423437
## X3988.HK 0.8587  0.0098205
```


Loadings Rotation : simplimax
0006.HK
X0002.HK
X0003.HK
X0941.HK
X0386.HK
X0857.HK
X0066.HK
X0762.HK
X0836.HK
X0494.HK
X1399.HK
X0291.HK
X0388.HK
X2600.HK
X1880.HK
X0322.HK
X1044.HK
X0293.HK
X0688.HK
X1109.HK
PC2
PC1
0.6
0.4
0.2
0.0
-0.2
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

5.2.5 Rotation : oblimin

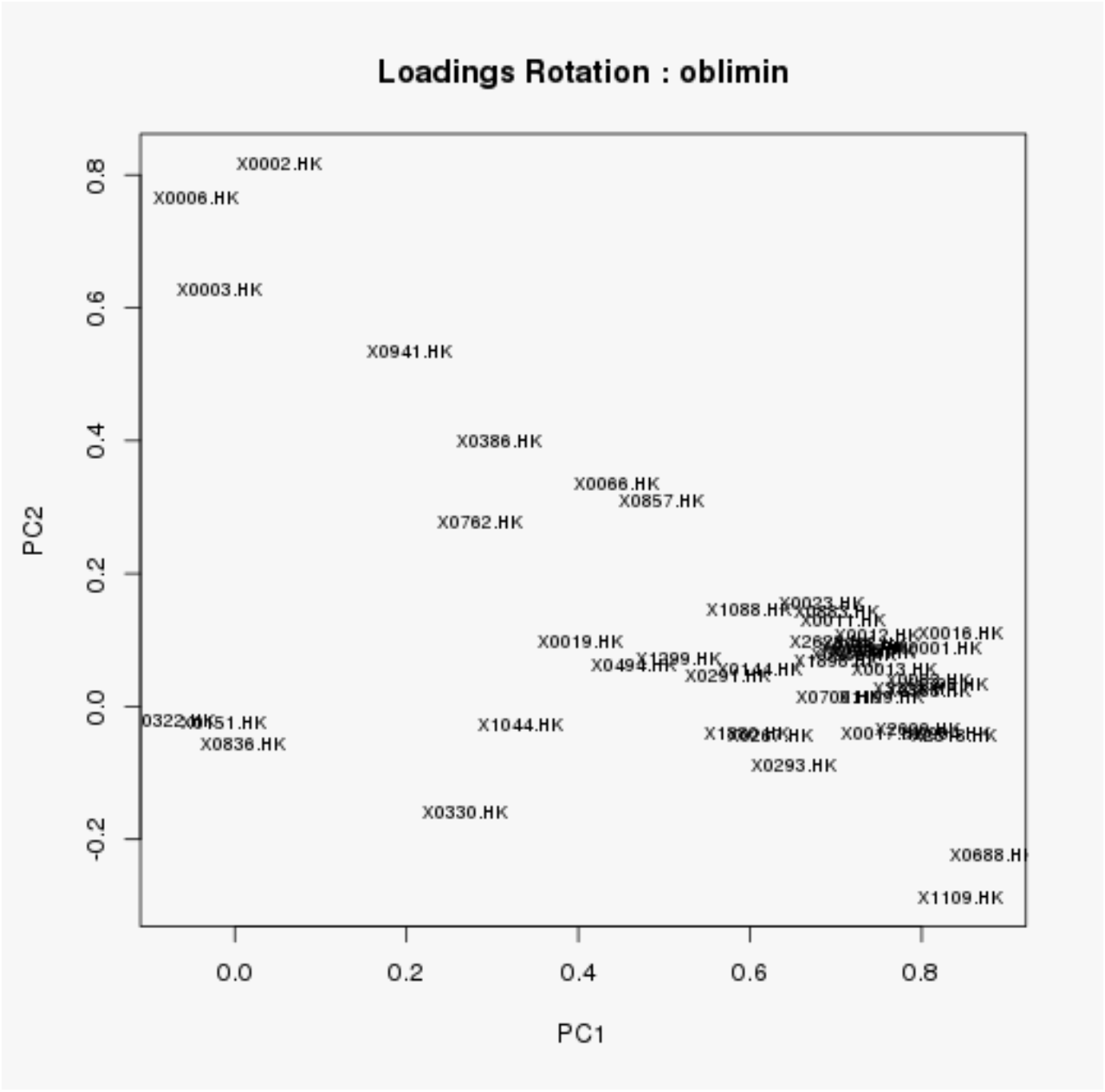
Direct oblimin rotation is the standard method when one wishes a non-orthogonal (oblique) solution – that is, one in which the factors are allowed to be correlated. This will result in higher eigenvalues but diminished interpretability of the factors.

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "oblimin")
## Standardized loadings (pattern matrix) based upon correlation matrix
##          item   PC1   PC2   PC3   PC4   PC5   h2   u2
## X0688.HK   27  0.88 -0.22  0.00  0.09 -0.06 0.68 0.32
## X1109.HK   37  0.85 -0.29  0.03  0.08  0.05 0.69 0.31
## X0016.HK   10  0.84  0.11 -0.04 -0.18  0.02 0.77 0.23
## X2318.HK   43  0.84 -0.04  0.03  0.11 -0.03 0.72 0.28
## X0004.HK    4  0.83 -0.04 -0.01 -0.13  0.04 0.67 0.33
## X1398.HK   40  0.83  0.03  0.07  0.16 -0.03 0.81 0.19
## X0001.HK    1  0.82  0.09  0.02 -0.24  0.06 0.80 0.20
## X0388.HK   25  0.81  0.02  0.06 -0.08  0.04 0.73 0.27
## X0083.HK   15  0.81  0.04 -0.12 -0.18  0.07 0.65 0.35
## X2600.HK   45  0.80 -0.03 -0.01  0.16 -0.02 0.65 0.35
## X3328.HK   47  0.79  0.03  0.01  0.18  0.06 0.76 0.24
## X0013.HK    9  0.77  0.06  0.05 -0.19  0.07 0.71 0.29
## X0017.HK   11  0.76 -0.04 -0.11 -0.17  0.15 0.60 0.40
## X1199.HK   38  0.75  0.01 -0.10  0.24  0.06 0.66 0.34
## X0012.HK    8  0.75  0.11 -0.04 -0.19  0.10 0.68 0.32
## X2388.HK   44  0.74  0.08  0.13 -0.07 -0.06 0.66 0.34
## X0005.HK    5  0.74  0.08  0.02  0.12  0.02 0.68 0.32
## X3988.HK   48  0.73  0.10  0.08  0.15  0.05 0.75 0.25
## X0101.HK   16  0.73  0.09 -0.11 -0.13  0.14 0.62 0.38
## X0939.HK   33  0.72  0.08  0.13  0.18  0.02 0.76 0.24
## X0011.HK    7  0.71  0.13  0.08 -0.31  0.02 0.69 0.31
## X0700.HK   28  0.70  0.02  0.15  0.10 -0.27 0.56 0.44
## X1898.HK   42  0.70  0.07  0.04  0.14  0.03 0.63 0.37
## X0883.HK   32  0.70  0.14  0.05  0.22 -0.02 0.71 0.29
## X2628.HK   46  0.69  0.10  0.04  0.16  0.02 0.64 0.36
## X0023.HK   13  0.68  0.16  0.14 -0.15 -0.11 0.61 0.39
## X0293.HK   21  0.65 -0.09  0.09 -0.16  0.03 0.46 0.54
## X0267.HK   19  0.62 -0.04  0.21  0.03  0.16 0.65 0.35
## X0144.HK   17  0.61  0.05  0.05  0.19  0.14 0.59 0.41
## X1088.HK   36  0.60  0.15  0.14  0.19  0.10 0.69 0.31
## X1880.HK   41  0.60 -0.04  0.16  0.13 -0.08 0.45 0.55
## X0291.HK   20  0.57  0.04  0.03 -0.05  0.07 0.40 0.60
## X1299.HK   39  0.52  0.07  0.11 -0.01  0.11 0.43 0.57
## X0857.HK   31  0.50  0.31  0.02  0.30  0.15 0.70 0.30
## X0494.HK   26  0.46  0.06 -0.01  0.12 -0.06 0.25 0.75
## X0066.HK   14  0.44  0.34  0.10 -0.18  0.15 0.58 0.42
## X0019.HK   12  0.40  0.10  0.27 -0.24  0.15 0.49 0.51
## X0002.HK    2  0.05  0.82  0.04 -0.07 -0.09 0.69 0.31
## X0006.HK    6 -0.04  0.77 -0.18  0.11 -0.12 0.57 0.43
## X0003.HK    3 -0.02  0.63  0.16 -0.17  0.26 0.60 0.40
## X0941.HK   34  0.20  0.53  0.12  0.20  0.11 0.58 0.42
## X0386.HK   24  0.31  0.40  0.02  0.37  0.24 0.70 0.30
## X0322.HK   22 -0.07 -0.02  0.82 -0.12  0.02 0.63 0.37
## X0151.HK   18 -0.01 -0.02  0.76  0.11  0.12 0.64 0.36
## X1044.HK   35  0.33 -0.03  0.55 -0.02 -0.21 0.51 0.49
## X0762.HK   29  0.29  0.28  0.21  0.38  0.07 0.56 0.44
## X0836.HK   30  0.01 -0.06  0.07  0.01  0.80 0.66 0.34
## X0330.HK   23  0.27 -0.16  0.02  0.16  0.49 0.42 0.58
```

```
##
##                  PC1  PC2  PC3  PC4  PC5
## SS loadings    20.68 3.33 2.64 1.55 1.90
## Proportion Var  0.43 0.07 0.06 0.03 0.04
## Cumulative Var  0.43 0.50 0.56 0.59 0.63
##
##  With component correlations of
##      PC1  PC2  PC3   PC4   PC5
## PC1 1.00 0.39 0.44  0.14  0.39
## PC2 0.39 1.00 0.15  0.04  0.19
## PC3 0.44 0.15 1.00  0.07  0.16
## PC4 0.14 0.04 0.07  1.00 -0.01
## PC5 0.39 0.19 0.16 -0.01  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  41.11 0.3
## The degrees of freedom for the model are 898  and the objective function was  6.47
##  0.3The number of observations was  311  with Chi Square =  1875  with prob <  4.1e-71
##  0.3
## Fit based upon off diagonal values = 0.99

##                PC1      PC2
## X0001.HK  0.818983  0.08862
## X0002.HK  0.052024  0.81756
## X0003.HK -0.019219  0.62727
## X0004.HK  0.829183 -0.04188
## X0005.HK  0.742162  0.08431
## X0006.HK -0.044741  0.76568
## X0011.HK  0.708537  0.12928
## X0012.HK  0.748872  0.10774
## X0013.HK  0.768235  0.05539
## X0016.HK  0.844915  0.10895
## X0017.HK  0.756231 -0.03968
## X0019.HK  0.401517  0.09796
## X0023.HK  0.684500  0.15562
## X0066.HK  0.444438  0.33553
## X0083.HK  0.807893  0.04103
## X0101.HK  0.731399  0.08748
## X0144.HK  0.611627  0.05473
## X0151.HK -0.012337 -0.02332
## X0267.HK  0.624752 -0.04304
## X0291.HK  0.574454  0.04476
## X0293.HK  0.651011 -0.08897
## X0322.HK -0.071689 -0.02195
## X0330.HK  0.267143 -0.15990
## X0386.HK  0.306980  0.40003
## X0388.HK  0.808668  0.02294
## X0494.HK  0.463598  0.06238
## X0688.HK  0.883229 -0.22419
## X0700.HK  0.702231  0.01549
## X0762.HK  0.285110  0.27865
## X0836.HK  0.009219 -0.05532
## X0857.HK  0.496056  0.30992
## X0883.HK  0.700281  0.14407
## X0939.HK  0.721061  0.07980
## X0941.HK  0.202895  0.53468
```

```
## X1044.HK  0.333230 -0.02634
## X1088.HK  0.597965  0.14573
## X1109.HK  0.846042 -0.28700
## X1199.HK  0.752472  0.01340
## X1299.HK  0.516442  0.07305
## X1398.HK  0.828266  0.03478
## X1880.HK  0.595905 -0.03898
## X1898.HK  0.701398  0.06910
## X2318.HK  0.836876 -0.04459
## X2388.HK  0.743468  0.08095
## X2600.HK  0.796106 -0.03250
## X2628.HK  0.694621  0.09777
## X3328.HK  0.791762  0.02550
## X3988.HK  0.734167  0.09561
```


Loadings Rotation : oblimin
PC2
PC1
0.8
0.6
0.4
0.2
0.0
-0.2
0.0
0.2
0.4
0.6
0.8
X0002.HK
X0006.HK
X0003.HK
X0941.HK
X0386.HK
X0066.HK
X0857.HK
X0762.HK
X1088.HK
X0019.HK
X0494.HK
X1399.HK
X0291.HK
X0016.HK
X0001.HK
X0013.HK
X1044.HK
X0836.HK
X0293.HK
X0330.HK
X1109.HK

5.2.6 Rotation : promax

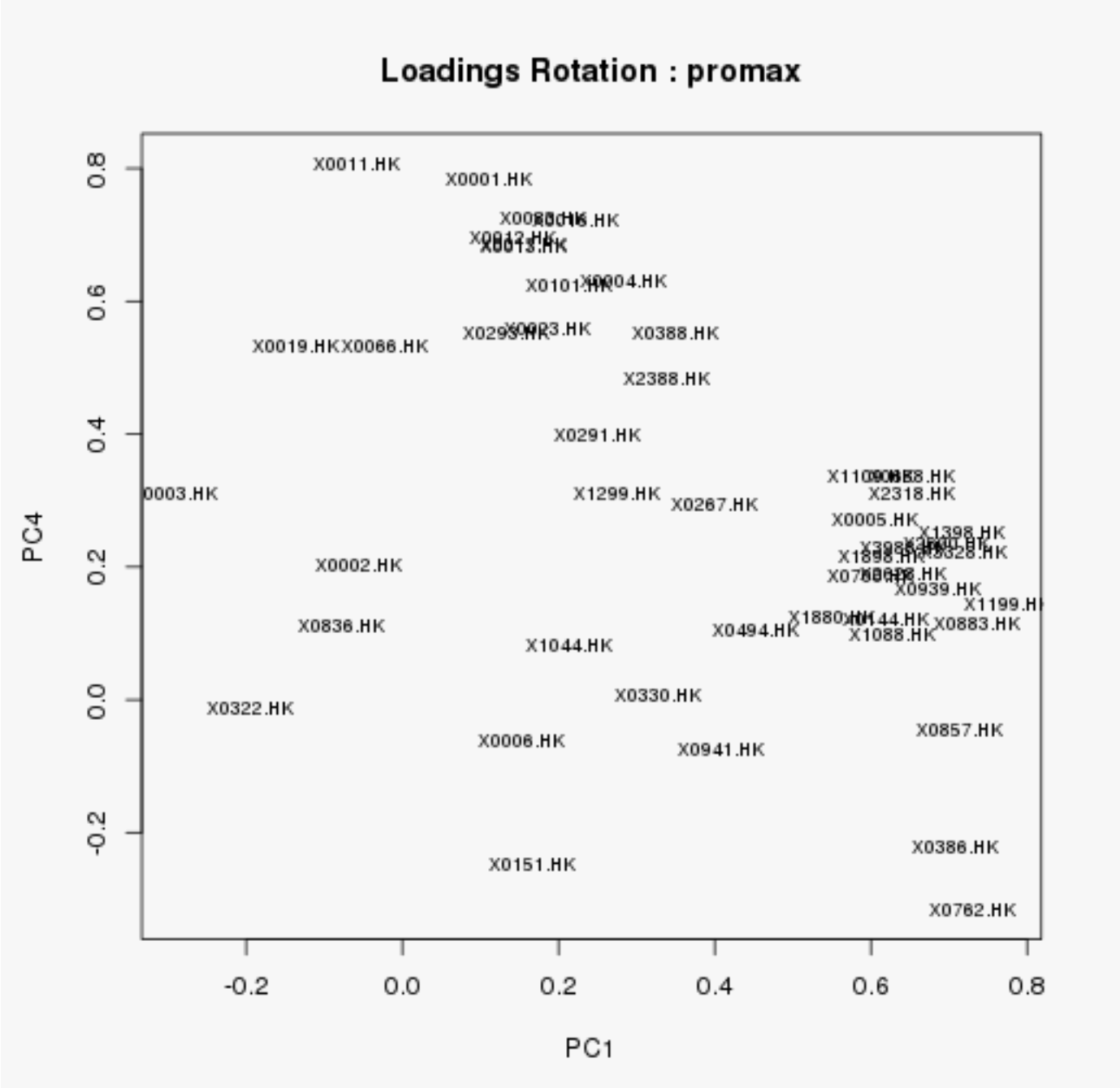
Promax rotation is an alternative non-orthogonal (oblique) rotation method which is computationally faster than the direct oblimin method and therefore is sometimes used for very large datasets.

```
## Principal Components Analysis
## Call: principal(r = dxtaRetok, nfactors = 5, rotate = "promax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##          item   PC1   PC4   PC2   PC3   PC5   h2   u2
## X1199.HK   38  0.78  0.14 -0.04 -0.16  0.04 0.66 0.34
## X0883.HK   32  0.74  0.11  0.10  0.00 -0.05 0.71 0.29
## X0762.HK   29  0.73 -0.32  0.22  0.17  0.04 0.56 0.44
## X3328.HK   47  0.72  0.22 -0.03 -0.05  0.03 0.76 0.24
## X1398.HK   40  0.72  0.25 -0.01  0.02 -0.06 0.81 0.19
## X0857.HK   31  0.71 -0.04  0.25 -0.05  0.10 0.70 0.30
## X0386.HK   24  0.71 -0.22  0.34 -0.05  0.20 0.70 0.30
## X2600.HK   45  0.70  0.24 -0.08 -0.06 -0.05 0.65 0.35
## X0939.HK   33  0.69  0.17  0.03  0.08 -0.01 0.76 0.24
## X2318.HK   43  0.65  0.31 -0.09 -0.02 -0.05 0.72 0.28
## X0688.HK   27  0.65  0.34 -0.26 -0.04 -0.07 0.68 0.32
## X2628.HK   46  0.64  0.19  0.05 -0.02 -0.02 0.64 0.36
## X3988.HK   48  0.64  0.23  0.05  0.02  0.02 0.75 0.25
## X1088.HK   36  0.63  0.10  0.09  0.09  0.07 0.69 0.31
## X0144.HK   17  0.62  0.12  0.00  0.00  0.11 0.59 0.41
## X1898.HK   42  0.61  0.22  0.03 -0.01  0.00 0.63 0.37
## X0005.HK    5  0.61  0.27  0.04 -0.03 -0.01 0.68 0.32
## X0700.HK   28  0.60  0.19 -0.01  0.12 -0.30 0.56 0.44
## X1109.HK   37  0.60  0.34 -0.33  0.00  0.04 0.69 0.31
## X1880.HK   41  0.55  0.12 -0.07  0.13 -0.09 0.45 0.55
## X0494.HK   26  0.45  0.10  0.04 -0.05 -0.08 0.25 0.75
## X0267.HK   19  0.40  0.29 -0.09  0.19  0.14 0.65 0.35
## X0011.HK    7 -0.06  0.81  0.12  0.06 -0.03 0.69 0.31
## X0001.HK    1  0.11  0.79  0.07 -0.02  0.02 0.80 0.20
## X0083.HK   15  0.18  0.72  0.02 -0.17  0.03 0.65 0.35
## X0016.HK   10  0.22  0.72  0.09 -0.09 -0.03 0.77 0.23
## X0012.HK    8  0.14  0.70  0.09 -0.08  0.06 0.68 0.32
## X0017.HK   11  0.15  0.69 -0.06 -0.15  0.12 0.60 0.40
## X0013.HK    9  0.16  0.68  0.03  0.02  0.03 0.71 0.29
## X0004.HK    4  0.28  0.63 -0.07 -0.05  0.01 0.67 0.33
## X0101.HK   16  0.21  0.62  0.06 -0.15  0.10 0.62 0.38
## X0023.HK   13  0.18  0.56  0.14  0.11 -0.15 0.61 0.39
## X0293.HK   21  0.13  0.55 -0.11  0.08  0.02 0.46 0.54
## X0388.HK   25  0.35  0.55 -0.01  0.02  0.00 0.73 0.27
## X0066.HK   14 -0.02  0.53  0.32  0.07  0.09 0.58 0.42
## X0019.HK   12 -0.14  0.53  0.08  0.27  0.13 0.49 0.51
## X2388.HK   44  0.34  0.48  0.06  0.09 -0.10 0.66 0.34
## X0291.HK   20  0.25  0.40  0.02  0.00  0.04 0.40 0.60
## X1299.HK   39  0.27  0.31  0.04  0.08  0.08 0.43 0.57
## X0002.HK    2 -0.06  0.20  0.82 -0.01 -0.17 0.69 0.31
## X0006.HK    6  0.15 -0.06  0.77 -0.24 -0.19 0.57 0.43
## X0003.HK    3 -0.29  0.31  0.62  0.14  0.20 0.60 0.40
## X0941.HK   34  0.41 -0.08  0.50  0.07  0.05 0.58 0.42
## X0322.HK   22 -0.19 -0.01 -0.04  0.88  0.03 0.63 0.37
## X0151.HK   18  0.17 -0.25 -0.06  0.81  0.13 0.64 0.36
## X1044.HK   35  0.21  0.08 -0.04  0.57 -0.21 0.51 0.49
## X0836.HK   30 -0.08  0.11 -0.11  0.06  0.81 0.66 0.34
## X0330.HK   23  0.33  0.01 -0.22  0.00  0.50 0.42 0.58
##
```

```
##                   PC1   PC4  PC2  PC3  PC5
## SS loadings    13.24 10.52 2.77 2.13 1.44
## Proportion Var  0.28  0.22 0.06 0.04 0.03
## Cumulative Var  0.28  0.49 0.55 0.60 0.63
##
##  With component correlations of
##      PC1  PC4  PC2  PC3  PC5
## PC1 1.00 0.74 0.38 0.53 0.40
## PC4 0.74 1.00 0.31 0.53 0.38
## PC2 0.38 0.31 1.00 0.22 0.31
## PC3 0.53 0.53 0.22 1.00 0.21
## PC5 0.40 0.38 0.31 0.21 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  41.11 0.3
## The degrees of freedom for the model are 898  and the objective function was  6.47
##  0.3The number of observations was  311  with Chi Square =  1875  with prob <  4.1e-71
##  0.3
## Fit based upon off diagonal values = 0.99

##                PC1       PC4
## X0001.HK  0.10939  0.785021
## X0002.HK -0.05678  0.201461
## X0003.HK -0.29090  0.310460
## X0004.HK  0.28361  0.629935
## X0005.HK  0.60562  0.271391
## X0006.HK  0.15162 -0.062494
## X0011.HK -0.05787  0.807423
## X0012.HK  0.14045  0.696051
## X0013.HK  0.15568  0.682821
## X0016.HK  0.22137  0.723247
## X0017.HK  0.15401  0.685274
## X0019.HK -0.13586  0.531057
## X0023.HK  0.18451  0.560087
## X0066.HK -0.02300  0.531155
## X0083.HK  0.18014  0.723862
## X0101.HK  0.21306  0.623253
## X0144.HK  0.61899  0.121348
## X0151.HK  0.16612 -0.249205
## X0267.HK  0.39870  0.293442
## X0291.HK  0.25047  0.397638
## X0293.HK  0.13266  0.552325
## X0322.HK -0.19418 -0.013534
## X0330.HK  0.32716  0.007398
## X0386.HK  0.70867 -0.222783
## X0388.HK  0.34919  0.550867
## X0494.HK  0.45257  0.104564
## X0688.HK  0.65102  0.337372
## X0700.HK  0.60087  0.188067
## X0762.HK  0.73021 -0.315674
## X0836.HK -0.07809  0.112886
## X0857.HK  0.71242 -0.043867
## X0883.HK  0.73691  0.114403
## X0939.HK  0.68516  0.166010
## X0941.HK  0.40735 -0.075452
## X1044.HK  0.21226  0.082320
```

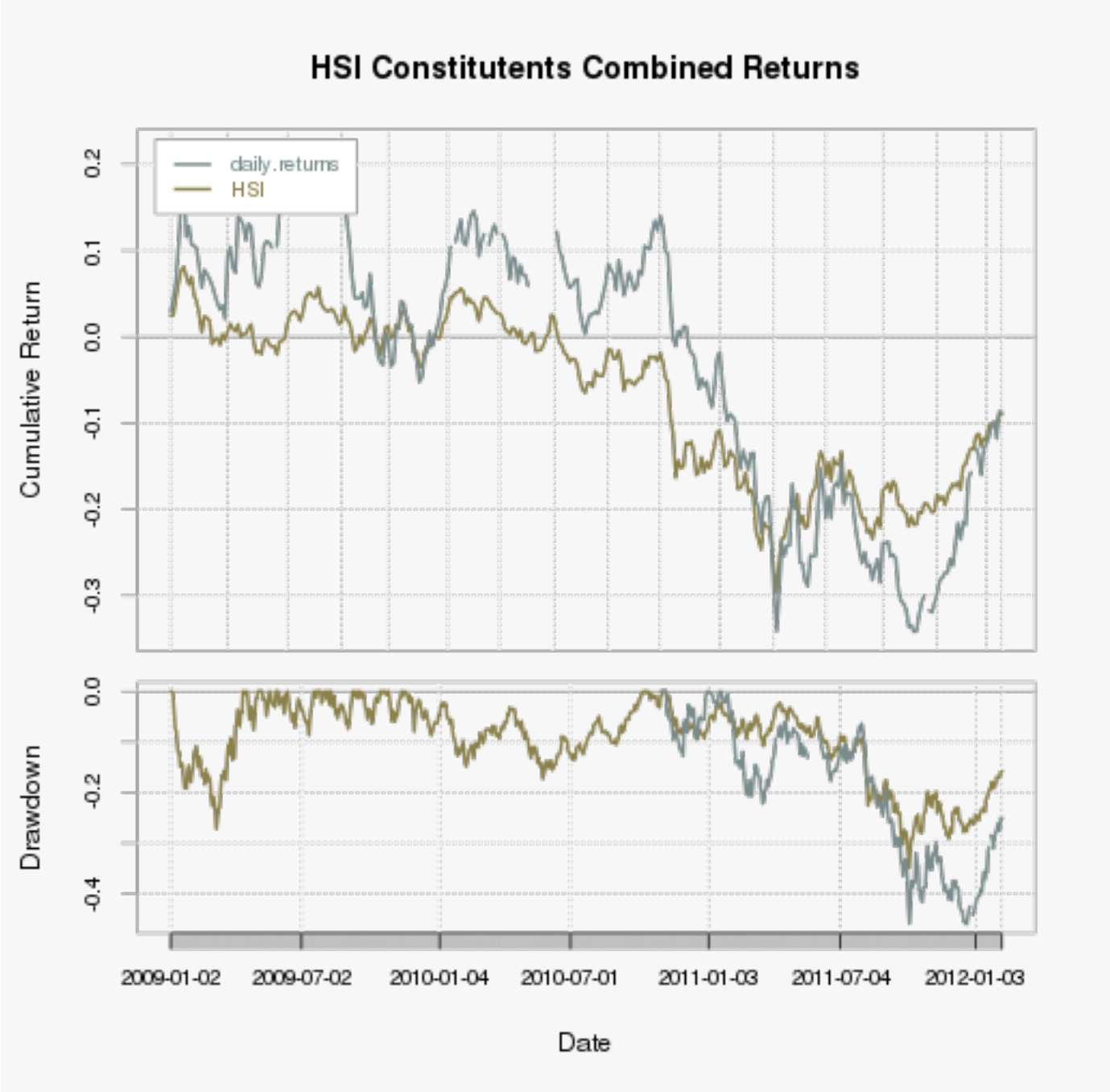
```
## X1088.HK  0.62768  0.097793
## X1109.HK  0.59908  0.337789
## X1199.HK  0.77560  0.143559
## X1299.HK  0.27447  0.311140
## X1398.HK  0.71643  0.250325
## X1880.HK  0.55083  0.124057
## X1898.HK  0.61335  0.217015
## X2318.HK  0.65124  0.310199
## X2388.HK  0.33979  0.482966
## X2600.HK  0.69627  0.235487
## X2628.HK  0.64150  0.189334
## X3328.HK  0.71827  0.222242
## X3988.HK  0.64094  0.228254
```



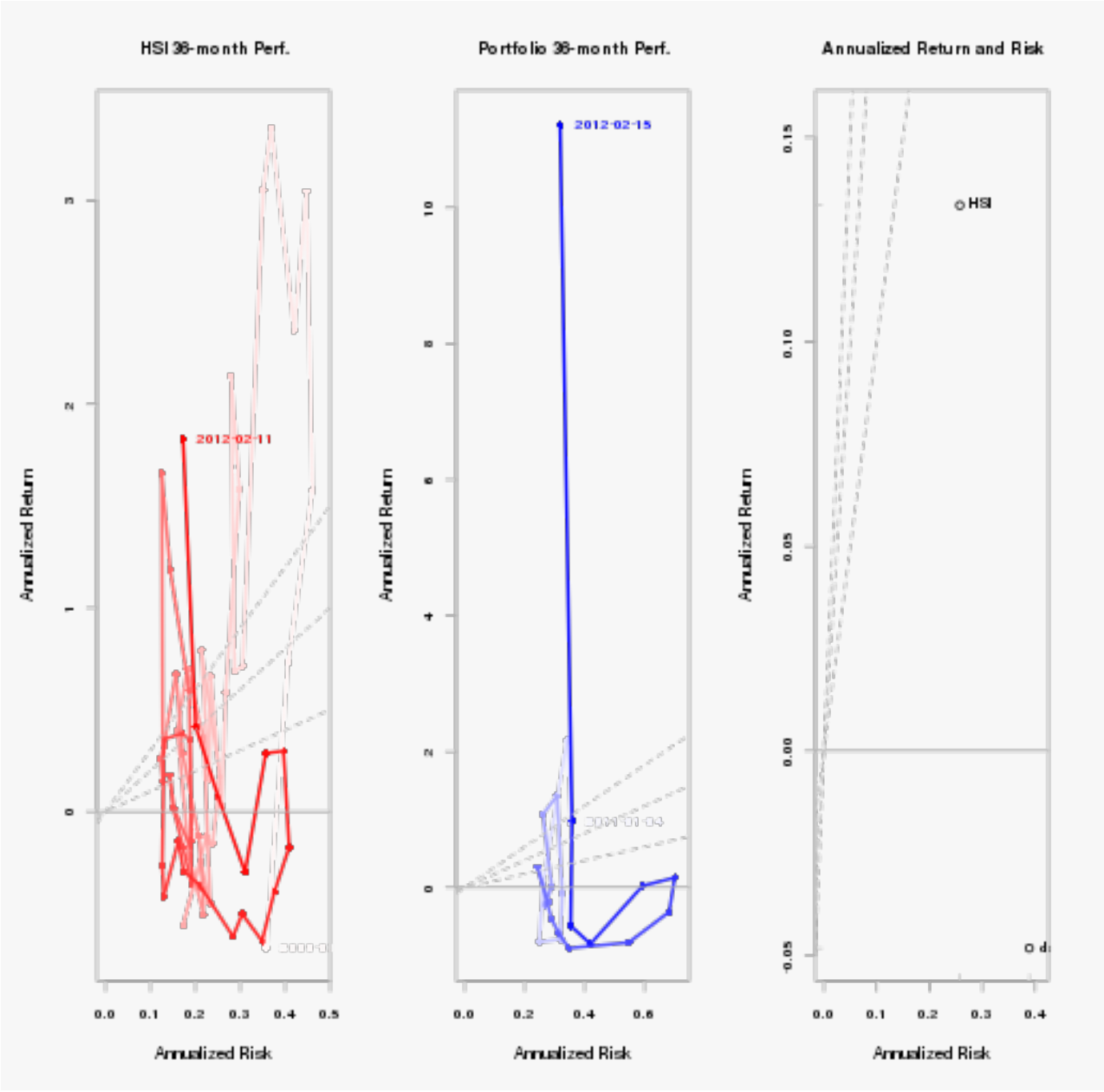
PCA is a science in itself and can not be fully covered and even less interpreted in this paper. The factors produced by principal component analysis are conceptualized as being linear combinations of the variables whereas the factors produced by common factor analysis are conceptualized as being latent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

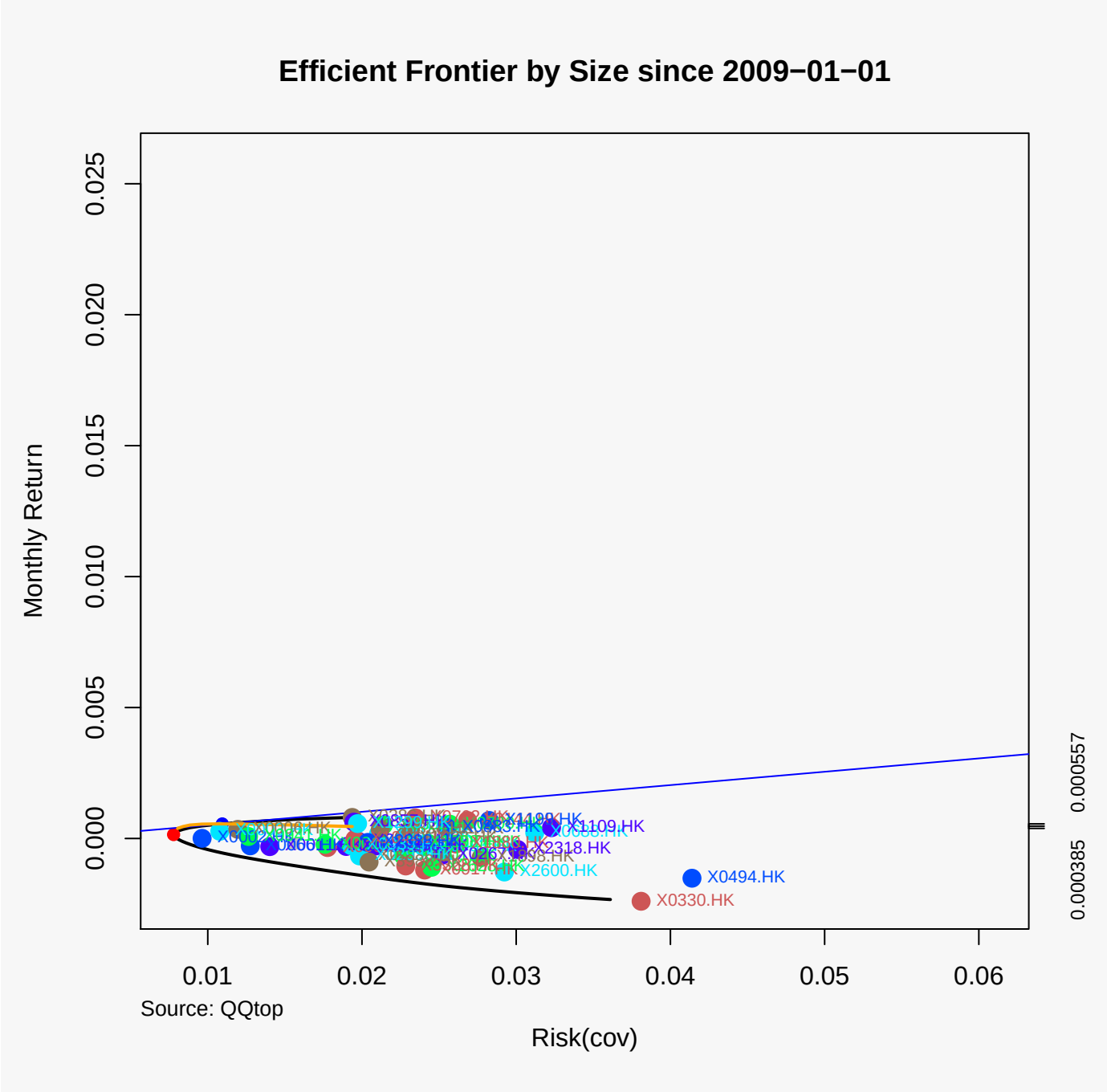
6.1 Performance Chart



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:
##    X0001.HK X0002.HK X0003.HK X0004.HK X0005.HK X0006.HK X0011.HK X0012.HK
```

```
## 1    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
## 25   0.0000   0.4281   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 37   0.0000   0.3456   0.1569   0.0000   0.0000   0.1615   0.0487   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##    X0013.HK X0016.HK X0017.HK X0019.HK X0023.HK X0066.HK X0083.HK X0101.HK
## 1    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 13   0.0000   0.0000   0.2606   0.1008   0.0000   0.0000   0.0000   0.0000
## 25   0.0000   0.0000   0.1207   0.0807   0.0000   0.0340   0.0000   0.0000
## 37   0.0000   0.0000   0.0000   0.0000   0.0000   0.0863   0.0000   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##    X0144.HK X0151.HK X0267.HK X0291.HK X0293.HK X0322.HK X0330.HK X0386.HK
## 1    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.9257   0.0000
## 13   0.0000   0.0000   0.0000   0.0000   0.0384   0.0000   0.3424   0.0000
## 25   0.0000   0.0000   0.0000   0.0000   0.0757   0.0000   0.1573   0.0000
## 37   0.0000   0.0039   0.0000   0.0000   0.0463   0.0336   0.0173   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   1.0000
##    X0388.HK X0494.HK X0688.HK X0700.HK X0762.HK X0836.HK X0857.HK X0883.HK
## 1    0.0000   0.0743   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 13   0.0000   0.0927   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 25   0.0000   0.0424   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 37   0.0000   0.0000   0.0000   0.0000   0.0000   0.0348   0.0000   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##    X0939.HK X0941.HK X1044.HK X1088.HK X1109.HK X1199.HK X1299.HK X1398.HK
## 1    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
## 25   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 37   0.0000   0.0191   0.0460   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
##    X1880.HK X1898.HK X2318.HK X2388.HK X2600.HK X2628.HK X3328.HK X3988.HK
## 1    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   0.1287   0.0363   0.0000
## 25   0.0000   0.0000   0.0000   0.0000   0.0000   0.0407   0.0136   0.0068
## 37   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##
## Covariance Risk Budgets:
##    X0001.HK X0002.HK X0003.HK X0004.HK X0005.HK X0006.HK X0011.HK X0012.HK
## 1    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
## 25   0.0000   0.1820   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 37   0.0000   0.3471   0.1454   0.0000   0.0000   0.1463   0.0533   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##    X0013.HK X0016.HK X0017.HK X0019.HK X0023.HK X0066.HK X0083.HK X0101.HK
## 1    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 13   0.0000   0.0000   0.2091   0.0493   0.0000   0.0000   0.0000   0.0000
## 25   0.0000   0.0000   0.1605   0.0746   0.0000   0.0217   0.0000   0.0000
## 37   0.0000   0.0000   0.0000   0.0000   0.0000   0.0938   0.0000   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##    X0144.HK X0151.HK X0267.HK X0291.HK X0293.HK X0322.HK X0330.HK X0386.HK
## 1    0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.9735   0.0000
## 13   0.0000   0.0000   0.0000   0.0000   0.0188   0.0000   0.5106   0.0000
## 25   0.0000   0.0000   0.0000   0.0000   0.0702   0.0000   0.3496   0.0000
## 37   0.0000   0.0036   0.0000   0.0000   0.0555   0.0288   0.0293   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   1.0000
##    X0388.HK X0494.HK X0688.HK X0700.HK X0762.HK X0836.HK X0857.HK X0883.HK
## 1    0.0000   0.0265   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
```

```
## 13   0.0000   0.0910   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 25   0.0000   0.0664   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 37   0.0000   0.0000   0.0000   0.0000   0.0000   0.0316   0.0000   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##    X0939.HK X0941.HK X1044.HK X1088.HK X1109.HK X1199.HK X1299.HK X1398.HK
## 1    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
## 25   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 37   0.0000   0.0188   0.0466   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
##    X1880.HK X1898.HK X2318.HK X2388.HK X2600.HK X2628.HK X3328.HK X3988.HK
## 1    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   0.0954   0.0259   0.0000
## 25   0.0000   0.0000   0.0000   0.0000   0.0000   0.0509   0.0165   0.0075
## 37   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
## 49   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
##
## Target Return and Risks:
##       mean      mu     Cov   Sigma    CVaR     VaR
## 1  -0.0023 -0.0023  0.0361  0.0361  0.0953  0.0521
## 13 -0.0015 -0.0015  0.0216  0.0216  0.0554  0.0386
## 25 -0.0008 -0.0008  0.0128  0.0128  0.0321  0.0270
## 37  0.0000  0.0000  0.0079  0.0079  0.0184  0.0132
## 49  0.0008  0.0008  0.0194  0.0194  0.0412  0.0302
##
## Description:
##  Thu Feb 16 22:44:58 2012 by user:
```

7 HSI Components Ratios

7.1 Sharpe Ratio - Combined

```
##                                          daily.returns
## Annualized StdDev Sharpe (Rf=0%, p=95%):       -0.1239
## Annualized VaR Sharpe (Rf=0%, p=95%):          -1.3050
## Annualized ES Sharpe (Rf=0%, p=95%):           -1.0164
```

7.2 Sharpe - Distinct

```
##                                          X0001.HK X0002.HK X0003.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.4137   0.5455    0.639
## Annualized VaR Sharpe (Rf=0%, p=95%):      4.4152   5.5004    6.117
## Annualized ES Sharpe (Rf=0%, p=95%):       3.4297   3.8601    2.623
##                                          X0004.HK X0005.HK X0006.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.7029  -0.0816   0.4989
## Annualized VaR Sharpe (Rf=0%, p=95%):      7.6880  -0.8525   5.1193
## Annualized ES Sharpe (Rf=0%, p=95%):       6.0238  -0.4136   3.6537
##                                          X0011.HK X0012.HK X0013.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):  -0.0266   0.4535   0.7272
## Annualized VaR Sharpe (Rf=0%, p=95%):     -0.3062   5.0507   7.9847
## Annualized ES Sharpe (Rf=0%, p=95%):      -0.2889   4.0406   6.1632
##                                          X0016.HK X0017.HK X0019.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.6247    0.147   0.4872
## Annualized VaR Sharpe (Rf=0%, p=95%):      6.6904    1.550   4.8451
## Annualized ES Sharpe (Rf=0%, p=95%):       5.2199    1.081   2.8686
##                                          X0023.HK X0066.HK X0083.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.5832   0.6247   0.4081
## Annualized VaR Sharpe (Rf=0%, p=95%):      7.2076   7.3170   4.3163
## Annualized ES Sharpe (Rf=0%, p=95%):       7.0304   6.2208   3.1430
##                                          X0101.HK X0144.HK X0151.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):    0.390   0.4875   0.8339
## Annualized VaR Sharpe (Rf=0%, p=95%):       4.271   5.2397   8.9125
## Annualized ES Sharpe (Rf=0%, p=95%):        3.384   4.1547   6.7610
##                                          X0267.HK X0291.HK X0293.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.3395   0.6981   0.5746
## Annualized VaR Sharpe (Rf=0%, p=95%):      3.9402   7.5632   6.0186
## Annualized ES Sharpe (Rf=0%, p=95%):       3.3520   6.0432   4.4849
##                                          X0322.HK X0330.HK X0386.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):    1.029  -0.5819   0.6878
## Annualized VaR Sharpe (Rf=0%, p=95%):      14.075  -5.3825   7.0842
## Annualized ES Sharpe (Rf=0%, p=95%):       14.075  -2.8732   5.3186
##                                          X0388.HK X0494.HK X0688.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.6592    0.161   0.2458
## Annualized VaR Sharpe (Rf=0%, p=95%):      7.4742    2.143   2.8482
## Annualized ES Sharpe (Rf=0%, p=95%):       6.0713    2.143   2.4367
##                                          X0700.HK X0762.HK X0836.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):    1.347   0.4053   0.0163
## Annualized VaR Sharpe (Rf=0%, p=95%):      14.261   4.4878   0.1669
## Annualized ES Sharpe (Rf=0%, p=95%):       10.568   3.5593   0.1325
##                                          X0857.HK X0883.HK X0939.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):    0.507   0.7925   0.3759
## Annualized VaR Sharpe (Rf=0%, p=95%):       5.104   8.3159   3.7293
## Annualized ES Sharpe (Rf=0%, p=95%):        3.858   6.2119   2.5815
##                                          X0941.HK X1044.HK X1088.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.0008    1.140    0.679
## Annualized VaR Sharpe (Rf=0%, p=95%):      0.0083   12.610    6.877
## Annualized ES Sharpe (Rf=0%, p=95%):       0.0063    9.793    5.265
##                                          X1109.HK X1199.HK X1299.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.2783    0.316   0.4038
## Annualized VaR Sharpe (Rf=0%, p=95%):      3.2636    3.482   4.1721
## Annualized ES Sharpe (Rf=0%, p=95%):       2.8027    2.786   2.6025
##                                          X1398.HK X1880.HK X1898.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.2431    1.163   0.3314
## Annualized VaR Sharpe (Rf=0%, p=95%):      2.7345   13.211   3.2452
```

```
## Annualized ES Sharpe (Rf=0%, p=95%):       2.2244   10.428   2.1985
##                                          X2318.HK X2388.HK X2600.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):   0.4208   0.9679  -0.0387
## Annualized VaR Sharpe (Rf=0%, p=95%):      4.4628  11.1029  -0.4120
## Annualized ES Sharpe (Rf=0%, p=95%):       3.1895   8.9700  -0.3262
##                                          X2628.HK X3328.HK X3988.HK
## Annualized StdDev Sharpe (Rf=0%, p=95%):  -0.0623   0.0417   0.4498
## Annualized VaR Sharpe (Rf=0%, p=95%):     -0.6200   0.4202   4.7276
## Annualized ES Sharpe (Rf=0%, p=95%):      -0.4346   0.3094   3.4203
```

7.3 Information Ratio - Combined

```
## [1] "Information Ratio :  0.1784"
```

7.4 Information Ratio - Distinct

```
##                         X0001.HK X0002.HK X0003.HK X0004.HK X0005.HK
## Information Ratio: HSI  -0.0065  -0.2202   0.0371   0.3198  -0.3488
##                         X0006.HK X0011.HK X0012.HK X0013.HK X0016.HK
## Information Ratio: HSI   -0.156  -0.4246   0.0599   0.2662   0.1608
##                         X0017.HK X0019.HK X0023.HK X0066.HK X0083.HK
## Information Ratio: HSI  -0.1515   0.0591   0.1636   0.0194   0.0743
##                         X0101.HK X0144.HK X0151.HK X0267.HK X0291.HK
## Information Ratio: HSI   0.0543   0.1697   0.3686   0.0275   0.2728
##                         X0293.HK X0322.HK X0330.HK X0386.HK X0388.HK
## Information Ratio: HSI   0.1546    0.511  -0.7672     0.22   0.2289
##                         X0494.HK X0688.HK X0700.HK X0762.HK X0836.HK
## Information Ratio: HSI   -0.061  -0.0495    0.867    0.027   -0.304
##                         X0857.HK X0883.HK X0939.HK X0941.HK X1044.HK
## Information Ratio: HSI   0.0807   0.3802  -0.0293  -0.3739   0.6381
##                         X1088.HK X1109.HK X1199.HK X1299.HK X1398.HK
## Information Ratio: HSI   0.2825   0.0083    0.036   0.5208  -0.1158
##                         X1880.HK X1898.HK X2318.HK X2388.HK X2600.HK
## Information Ratio: HSI   0.7718   0.0407    0.095   0.4782  -0.2705
##                         X2628.HK X3328.HK X3988.HK
## Information Ratio: HSI  -0.3559  -0.2776   0.0394
```

8 HSI Components Table Latest Quotes

```
## [1] "Date :  2012-02-16 02:59:00"

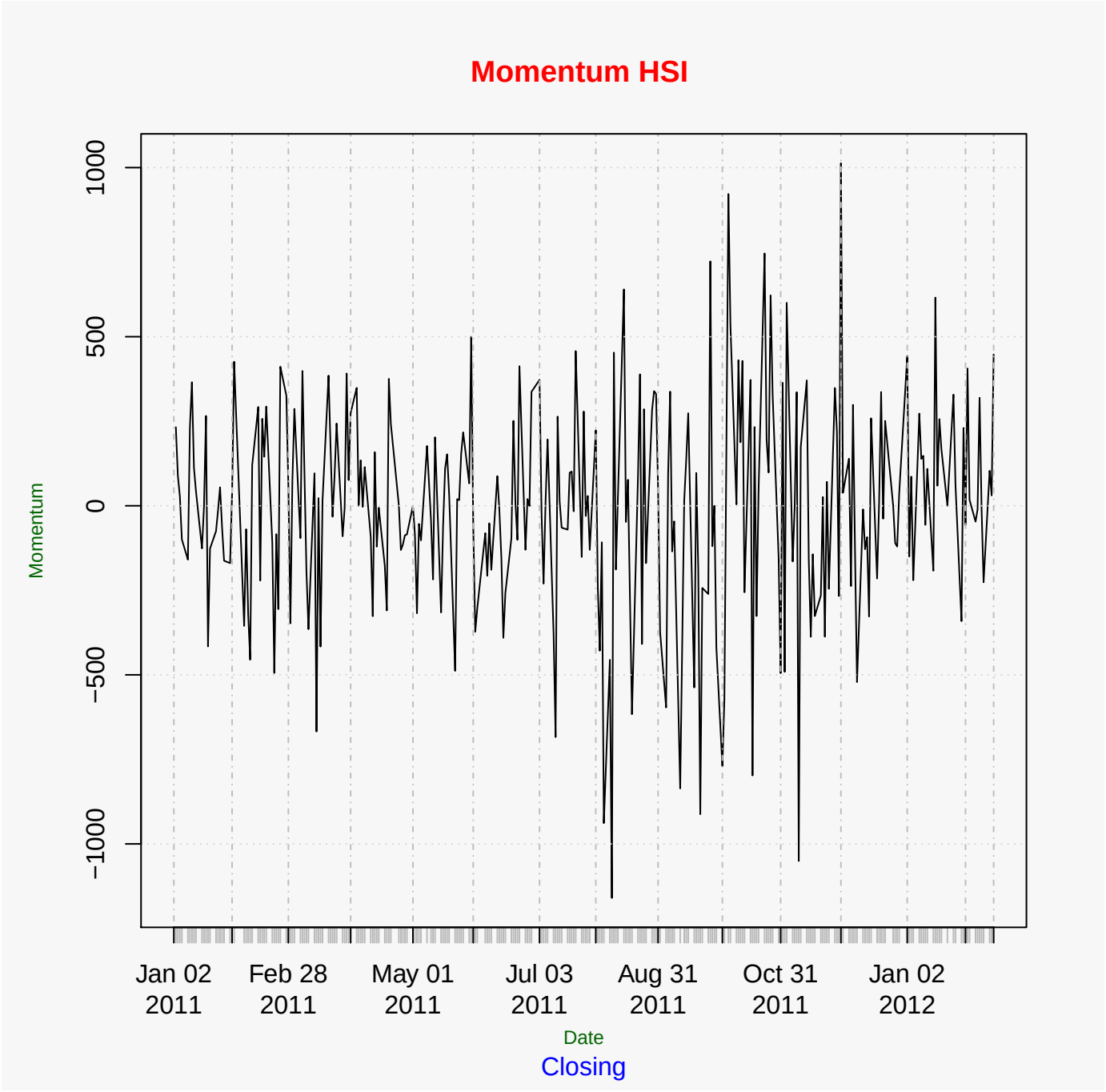
##                    Name    Bid    Ask Change   52-week Range
## 0001.HK     CHEUNG KONG 111.80 112.00  -0.30  79.10 - 137.60
## 0002.HK    CLP HOLDINGS  65.00  65.15   0.00   59.85 - 75.20
## 0003.HK  HK & CHINA GAS  18.50  18.58   0.04   16.70 - 19.68
## 0004.HK  WHARF HOLDINGS  48.25  48.35   0.65   33.15 - 63.80
## 0005.HK   HSBC HOLDINGS  69.35  69.40  -0.45   56.35 - 91.90
## 0006.HK    POWER ASSETS  55.50  55.60   0.10   48.10 - 64.80
## 0011.HK  HANG SENG BANK 102.00 102.30  -0.60  84.40 - 134.40
## 0012.HK  HENDERSON LAND  48.00  48.05  -0.15   33.20 - 61.50
## 0013.HK       HUTCHISON  77.65  77.75  -0.65   53.60 - 97.45
## 0016.HK         SHK PPT 118.70 118.80   0.10  85.45 - 147.00
## 0017.HK   NEW WORLD DEV  10.00  10.02   0.22    7.00 - 17.98
## 0019.HK SWIRE PACIFIC A  88.10  88.20   0.40  79.30 - 137.20
## 0023.HK  BANK OF E ASIA  30.35  30.50   0.60   21.85 - 36.60
## 0066.HK MTR CORPORATION  26.80  26.90  -0.30   22.45 - 31.55
## 0083.HK       SINO LAND  13.58  13.60  -0.04    9.33 - 18.90
## 0101.HK   HANG LUNG PPT  28.70  28.75  -0.30   20.85 - 40.50
## 0144.HK  CHINA MER HOLD  28.55  28.60  -0.25   19.00 - 37.60
## 0151.HK WANT WANT CHINA   7.31   7.33   0.20     5.68 - 8.30
## 0267.HK   CITIC PACIFIC  15.28  15.30  -0.36   10.26 - 24.60
## 0291.HK CHINA RESOURCES  28.85  28.90   0.30   24.10 - 35.50
## 0293.HK  CATHAY PAC AIR  15.64  15.66  -0.06   11.80 - 24.10
## 0322.HK          TINGYI  22.10  22.15  -0.35   17.32 - 26.00
## 0330.HK ESPRIT HOLDINGS  14.30  14.34  -0.24    7.55 - 45.65
## 0386.HK    SINOPEC CORP   9.17   9.18  -0.14     6.22 - 8.90
## 0388.HK            HKEX 144.70 145.00  -2.10  99.15 - 198.60
## 0494.HK       LI & FUNG  17.70  17.76  -0.54   10.82 - 51.95
## 0688.HK  CHINA OVERSEAS  15.30  15.32  -0.16    9.99 - 17.86
## 0700.HK         TENCENT 199.40 199.60   5.70 139.90 - 230.80
## 0762.HK    CHINA UNICOM  14.54  14.56  -0.22   10.24 - 17.68
## 0836.HK CHINA RES POWER  15.30  15.42  -0.06   10.82 - 16.44
## 0857.HK      PETROCHINA  11.54  11.58  -0.10    8.59 - 12.50
## 0883.HK           CNOOC  17.86  17.88   0.12   11.20 - 21.30
## 0939.HK             CCB   6.38   6.39  -0.07     4.41 - 8.47
## 0941.HK    CHINA MOBILE  81.55  81.60   0.20   68.05 - 83.80
## 1044.HK    HENGAN INT'L  70.65  70.70   0.45   54.10 - 75.40
## 1088.HK   CHINA SHENHUA  35.85  35.95   0.05   27.10 - 40.20
## 1109.HK  CHINA RES LAND  14.48  14.50  -0.32    7.28 - 17.24
## 1199.HK   COSCO PACIFIC  12.50  12.58  -0.02    7.52 - 17.16
## 1299.HK             AIA  26.40  26.50  -0.40   19.84 - 29.90
## 1398.HK            ICBC   5.56   5.57   0.02     3.46 - 6.90
## 1880.HK     BELLE INT'L  12.46  12.48  -0.38   11.56 - 17.54
## 1898.HK      CHINA COAL  10.20  10.24  -0.08    6.59 - 15.08
## 2318.HK         PING AN  64.95  65.00  -1.45   37.35 - 96.25
## 2388.HK   BOC HONG KONG  21.70  21.85   0.05   14.24 - 29.40
## 2600.HK          CHALCO   4.16   4.17  -0.12     3.20 - 8.30
## 2628.HK      CHINA LIFE  22.85  22.90  -0.30   17.04 - 36.90
## 3328.HK        BANKCOMM   6.24   6.26   0.06     4.15 - 9.53
## 3988.HK   BANK OF CHINA   3.30   3.31  -0.05     2.20 - 5.02
```

9 Hang Seng Index

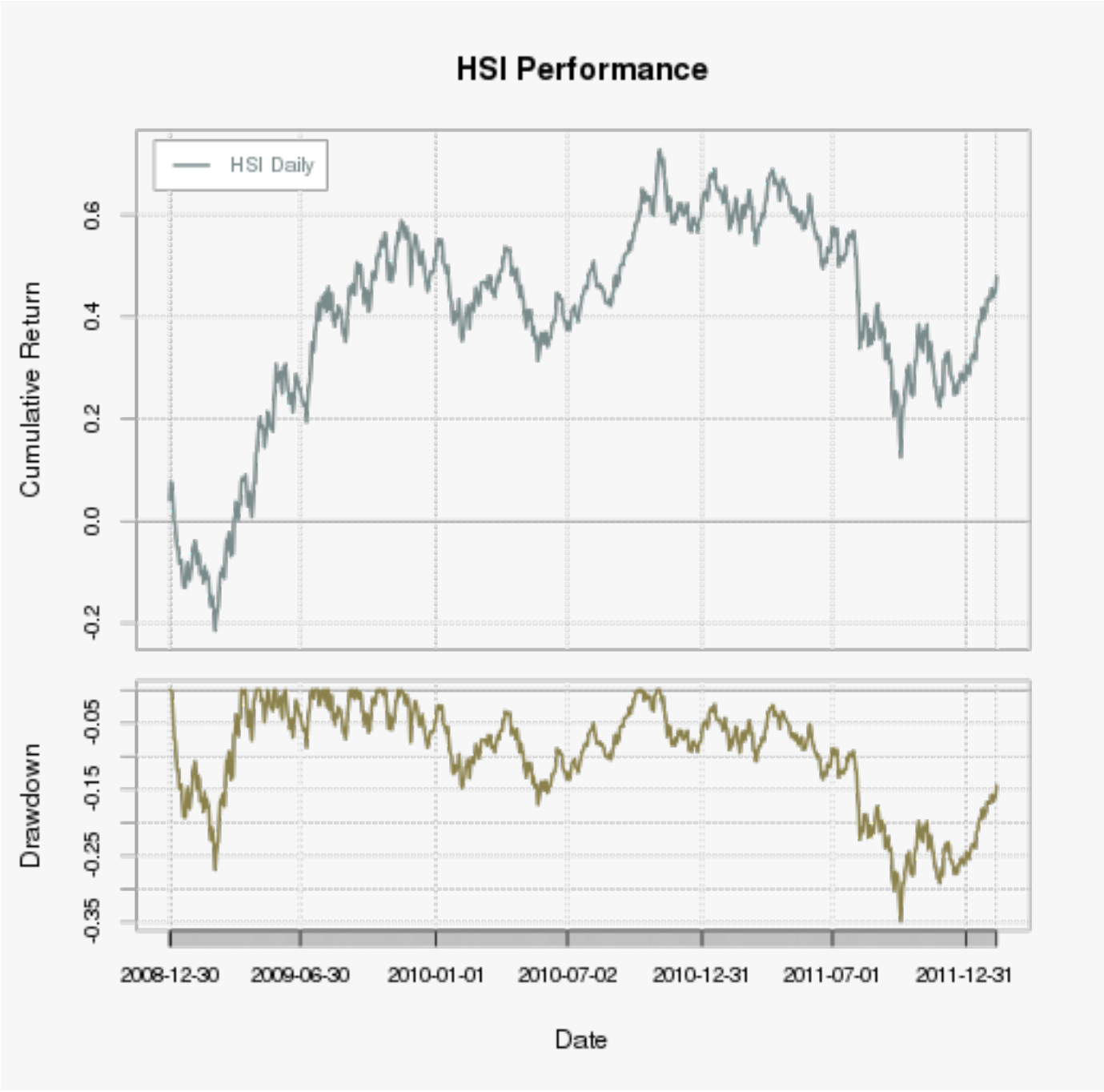
Latest Hang Seng Index

	Trade Time	Name	Last	Change	Days Range	52−week Range
^HSI	2012−02−16 03:01:00	HANG SENG INDEX	21277	−87.95	21157.551 − 21317.721	16170.30 − 24468.60

9.1 Hang Seng Index - Momentum



9.2 HSI Performance



9.3 HSI Ratios

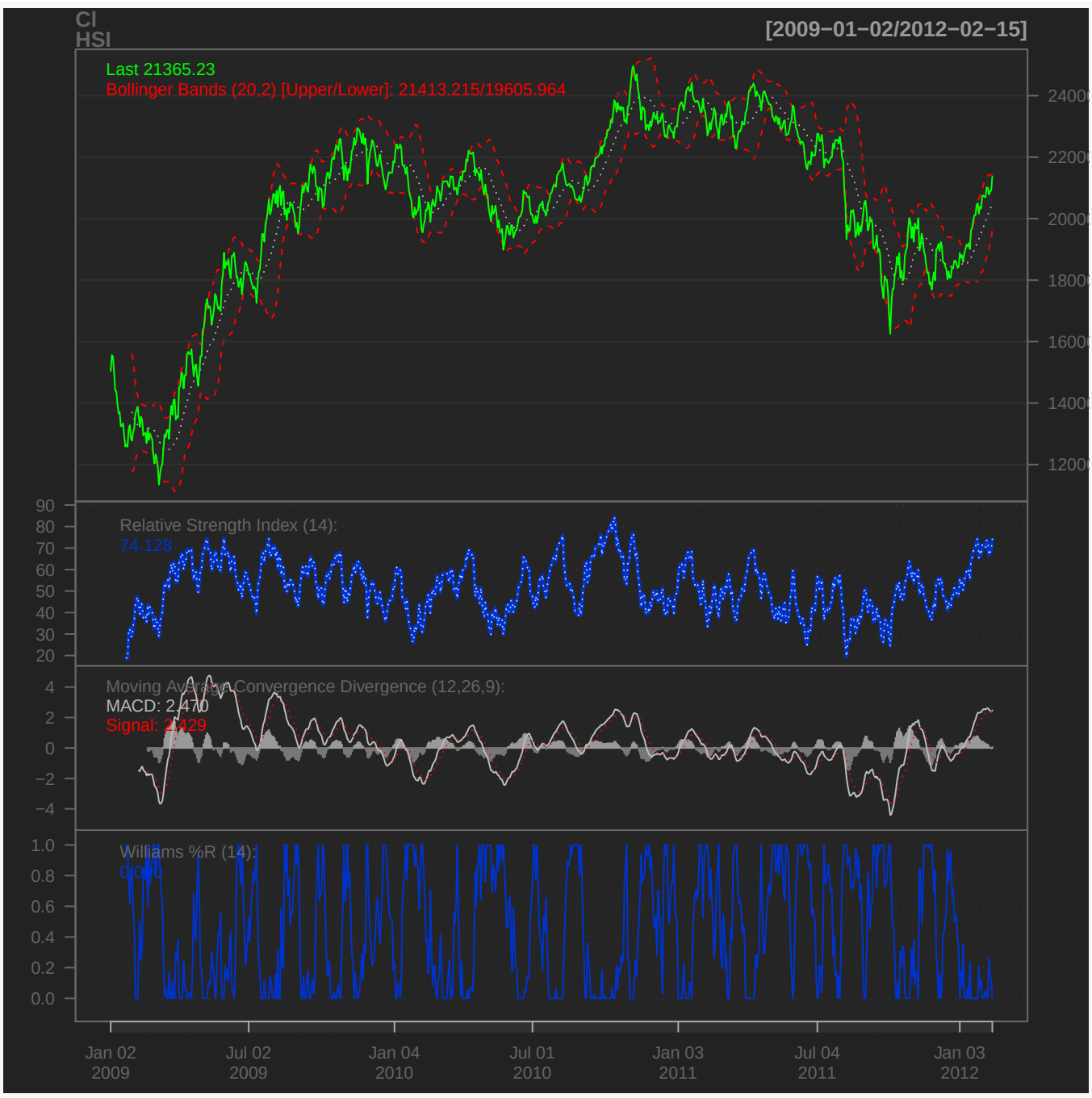
```
##               RSI
## 2012-02-01 71.38
## 2012-02-02 71.56
## 2012-02-05 70.25
## 2012-02-06 69.93
## 2012-02-07 73.71
## 2012-02-08 73.45
## 2012-02-09 66.59
## 2012-02-12 68.06
## 2012-02-13 68.50
## 2012-02-14 74.13
```

```
##              macd signal
## 2012-02-01 2.465  2.034
## 2012-02-02 2.540  2.135
## 2012-02-05 2.550  2.218
## 2012-02-06 2.523  2.279
## 2012-02-07 2.597  2.343
## 2012-02-08 2.620  2.398
## 2012-02-09 2.519  2.422
## 2012-02-12 2.451  2.428
## 2012-02-13 2.380  2.419
## 2012-02-14 2.470  2.429
```

```
## [1] "BBands"
```

```
##                dn  mavg    up   pctB
## 2012-02-01 18271 19626 20980 0.9112
## 2012-02-02 18353 19727 21101 0.8748
## 2012-02-05 18451 19822 21192 0.8240
## 2012-02-06 18629 19927 21226 0.7973
## 2012-02-07 18749 20035 21320 0.8826
## 2012-02-08 18874 20135 21396 0.8469
## 2012-02-09 19011 20217 21423 0.7352
## 2012-02-12 19184 20306 21429 0.7588
## 2012-02-13 19361 20392 21423 0.7550
## 2012-02-14 19606 20510 21413 0.9734
```

```
##             WPR %
## 2012-02-01  0.00
## 2012-02-02  0.00
## 2012-02-05  2.70
## 2012-02-06  5.12
## 2012-02-07  0.00
## 2012-02-08  0.79
## 2012-02-09 25.83
## 2012-02-12 14.43
## 2012-02-13 11.73
## 2012-02-14  0.00
```


CI
HSI
[2009−01−02/2012−02−15]
Last 21365.23
Bollinger Bands (20,2) [Upper/Lower]: 21413.215/19605.964
Relative Strength Index (14):
74.128
Moving Average Convergence Divergence (12,26,9):
MACD: 2.470
Signal: 2.429
Williams %R (14):
Jan 02 2009
Jul 02 2009
Jan 04 2010
Jul 01 2010
Jan 03 2011
Jul 04 2011
Jan 03 2012

9.4 HSI Volatility

9.5 HSI Statistics

```
##                                           HSI-Daily HSI-Monthly
## Annualized StdDev Sharpe (Rf=0%, p=95%):    0.5184      0.4858
## Annualized VaR Sharpe (Rf=0%, p=95%):       5.3287      1.1773
## Annualized ES Sharpe (Rf=0%, p=95%):        3.9244      0.9219
```

```
##          HSI-Daily HSI-Monthly
## Skewness    0.1124     0.08656
```

```
##          HSI-Daily HSI-Monthly
## Kurtosis     1.405    -0.08918
```

```
##      Index              HSI Daily
##  Min.   :2008-12-31   Min.   :-0.056605
##  1st Qu.:2009-10-12   1st Qu.:-0.008056
##  Median :2010-07-24   Median : 0.000304
##  Mean   :2010-07-23   Mean   : 0.000628
##  3rd Qu.:2011-05-02   3rd Qu.: 0.010223
##  Max.   :2012-02-13   Max.   : 0.074147
```

```
##      Index             HSI Monthly
##  Min.   :2009-01-28   Min.   :-0.14329
##  1st Qu.:2009-11-05   1st Qu.:-0.01913
##  Median :2010-08-13   Median : 0.00817
##  Mean   :2010-08-13   Mean   : 0.01161
##  3rd Qu.:2011-05-21   3rd Qu.: 0.04308
##  Max.   :2012-02-13   Max.   : 0.17074
```

10 Dataset First and Last Rows Info

```
##            X0001.HK.Close
## 2009-01-02           76.9
## 2012-02-15          112.9
##            X0002.HK.Close
## 2009-01-02          52.40
## 2012-02-15          65.25
##            X0003.HK.Close
## 2009-01-02          12.08
## 2012-02-15          18.46
##            X0004.HK.Close
## 2009-01-02           22.0
## 2012-02-15           47.9
##            X0005.HK.Close
## 2009-01-02          77.00
## 2012-02-15          69.75
##            X0006.HK.Close
## 2009-01-02          42.75
## 2012-02-15          55.45
##            X0011.HK.Close
## 2009-01-02          104.7
## 2012-02-15          102.6
##            X0012.HK.Close
## 2009-01-02          30.35
## 2012-02-15          48.15
##            X0013.HK.Close
## 2009-01-02          39.85
## 2012-02-15          78.40
##            X0016.HK.Close
## 2009-01-02           67.3
## 2012-02-15          119.0
##            X0017.HK.Close
## 2009-01-02           8.18
## 2012-02-15           9.82
##            X0019.HK.Close
## 2009-01-02          55.75
## 2012-02-15          87.95
##            X0023.HK.Close
## 2009-01-02          16.68
## 2012-02-15          29.90
##            X0066.HK.Close
## 2009-01-02          18.08
## 2012-02-15          27.20
##            X0083.HK.Close
## 2009-01-02           8.36
## 2012-02-15          13.62
##            X0101.HK.Close
## 2009-01-02          18.36
## 2012-02-15          29.15
##            X0144.HK.Close
## 2009-01-02           15.4
## 2012-02-15           28.8
##            X0151.HK.Close
## 2009-01-02           3.17
## 2012-02-15           7.10
##            X0267.HK.Close
```

```
## 2009-01-02          10.20
## 2012-02-15          15.66
##            X0291.HK.Close
## 2009-01-02           14.0
## 2012-02-15           28.6
##            X0293.HK.Close
## 2009-01-02           8.91
## 2012-02-15          15.70
##            X0322.HK.Close
## 2009-01-02           8.98
## 2012-02-15          22.45
##            X0330.HK.Close
## 2009-01-02          44.80
## 2012-02-15          14.54
##            X0386.HK.Close
## 2009-01-02           4.96
## 2012-02-15           9.33
##            X0388.HK.Close
## 2009-01-02           76.6
## 2012-02-15          147.1
##            X0494.HK.Close
## 2009-01-02          14.04
## 2012-02-15          18.24
##            X0688.HK.Close
## 2009-01-02          11.22
## 2012-02-15          15.48
##            X0700.HK.Close
## 2009-01-01           50.0
## 2012-02-15          193.5
##            X0762.HK.Close
## 2009-01-01           9.63
## 2012-02-15          14.72
##            X0836.HK.Close
## 2009-01-02          15.12
## 2012-02-15          15.38
##            X0857.HK.Close
## 2009-01-02           7.20
## 2012-02-15          11.66
##            X0883.HK.Close
## 2009-01-02           7.59
## 2012-02-15          17.74
##            X0939.HK.Close
## 2009-01-02           4.52
## 2012-02-15           6.47
##            X0941.HK.Close
## 2009-01-02          81.20
## 2012-02-15          81.25
##            X1044.HK.Close
## 2009-01-01          24.90
## 2012-02-15          70.25
##            X1088.HK.Close
## 2009-01-02           17.4
## 2012-02-15           35.9
##            X1109.HK.Close
## 2009-01-02           9.90
## 2012-02-15          14.82
##            X1199.HK.Close
```

```
## 2009-01-02           8.07
## 2012-02-15          12.60
##            X1299.HK.Close
## 2010-10-29          23.10
## 2012-02-15          26.85
##            X1398.HK.Close
## 2009-01-02           4.30
## 2012-02-15           5.54
##            X1880.HK.Close
## 2009-01-02            3.5
## 2012-02-15           12.9
##            X1898.HK.Close
## 2009-01-02           6.55
## 2012-02-15          10.28
##            X2318.HK.Close
## 2009-01-02          39.60
## 2012-02-15          66.55
##            X2388.HK.Close
## 2009-01-02           9.06
## 2012-02-15          21.80
##            X2600.HK.Close
## 2009-01-02           4.55
## 2012-02-15           4.28
##            X2628.HK.Close
## 2009-01-02          24.75
## 2012-02-15          23.10
##            X3328.HK.Close
## 2009-01-02           5.91
## 2012-02-15           6.19
##            X3988.HK.Close
## 2009-01-02           2.17
## 2012-02-15           3.35
```

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.
Generating this document takes about 200 secs. on an i7 CPU
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Improvements and changes without further notice.

This is the End !