# Empirical Asset Pricing: Problem Set 4

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## 0.1 Exercise 1

### 0.1.1 a

Table below shows the sample means, standard deviations and Sharpe Ratios of these 30 portfolios. Average returns are around 1 percent and the Sharpe Ratio is between 0.09 and 0.21. The average returns and Sharpe Ratios do not show any pattern across portfolios. Thus, we do not think there is a discernible pattern in them.

| portfolio | food | beer | smoke | games | books | hshld | clths | hlth | chems | txtls |
|---|---|---|---|---|---|---|---|---|---|---|
| mean | 0.9778 | 1.2087 | 1.1698 | 1.1234 | 0.9227 | 0.9236 | 0.9248 | 1.0799 | 1.0601 | 1.0026 |
| standard deviation | 4.7614 | 7.2452 | 5.7979 | 8.9731 | 7.1970 | 5.8481 | 6.1112 | 5.5942 | 6.3346 | 7.6750 |
| Sharpe Ratio | 0.2054 | 0.1668 | 0.2018 | 0.1252 | 0.1282 | 0.1579 | 0.1513 | 0.1930 | 0.1674 | 0.1306 |
| portfolio | cnstr | steel | fabpr | elceq | autos | carry | mines | coal | oil | util |
| mean | 0.9392 | 0.9188 | 1.0508 | 1.1723 | 1.0813 | 1.1254 | 0.9122 | 1.0742 | 1.0285 | 0.8789 |
| standard deviation | 6.9108 | 8.4729 | 7.2501 | 7.6269 | 8.0051 | 7.6173 | 7.3175 | 10.8620 | 6.0951 | 5.5496 |
| Sharpe Ratio | 0.1359 | 0.1084 | 0.1449 | 0.1537 | 0.1351 | 0.1477 | 0.1247 | 0.0989 | 0.1687 | 0.1584 |
| portfolio | telcm | servs | buseq | paper | trans | whlsl | rtail | meals | fin | other |
| mean | 0.8620 | 1.2051 | 1.1155 | 1.0319 | 0.9279 | 0.8287 | 1.0271 | 1.0577 | 1.0187 | 0.8039 |
| standard deviation | 4.6019 | 8.3869 | 6.7947 | 5.8925 | 7.1803 | 7.3691 | 5.9903 | 6.5241 | 6.8279 | 6.8061 |
| Sharpe Ratio | 0.1873 | 0.1437 | 0.1642 | 0.1751 | 0.1305 | 0.1125 | 0.1715 | 0.1621 | 0.1492 | 0.1181 |

### 0.1.2 b

Tables below show the alpha, beta, test statistics of alpha and beta and the GRS F-statistic and p-value for the time regression. Since the p-value here is 0.0028, which is relatively low, we can reject the null hypothesis illustrated below.

$$R_{pt} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + e_{it}.$$

| portfolio | food | beer | smoke | games | books | hshld | clths | hlth | chems | txtls |
|---|---|---|---|---|---|---|---|---|---|---|
| alpha | 0.2182 | 0.3171 | 0.4822 | -0.0591 | -0.0770 | 0.0578 | 0.1171 | 0.2553 | 0.1030 | -0.0173 |
| alpha t-stat | 2.7185 | 1.9954 | 3.3518 | -0.3860 | -0.6215 | 0.5742 | 0.8932 | 2.5144 | 1.1272 | -0.1213 |
| beta | 0.7394 | 0.9421 | 0.6287 | 1.3886 | 1.1080 | 0.9023 | 0.8132 | 0.8393 | 1.0426 | 1.1389 |
| beta t-stat | 49.8295 | 32.0653 | 23.6334 | 49.0466 | 48.3688 | 48.4523 | 33.5600 | 44.7127 | 61.6934 | 43.2412 |
| portfolio | cnstr | steel | fabpr | elceq | autos | carry | mines | coal | oil | util |
| alpha | -0.1024 | -0.2431 | -0.0360 | 0.0579 | -0.0122 | 0.0732 | 0.0427 | -0.0505 | 0.1850 | 0.0940 |
| alpha t-stat | -1.1638 | -1.8293 | -0.4076 | 0.5791 | -0.0915 | 0.5726 | 0.2549 | -0.1982 | 1.5364 | 0.8418 |
| beta | 1.1724 | 1.3570 | 1.2416 | 1.2841 | 1.2521 | 1.8887 | 0.9082 | 1.2998 | 0.8681 | 0.7783 |
| beta t-stat | 72.0538 | 55.2303 | 76.0684 | 69.4314 | 50.6132 | 50.3290 | 29.3366 | 27.6047 | 38.9888 | 37.7191 |
| portfolio | telcm | servs | buseq | paper | trans | whlsl | rtail | meals | fin | other |
| alpha | 0.1532 | 0.3976 | 0.1357 | 0.1321 | -0.0912 | -0.1587 | 0.1205 | 0.1638 | -0.0193 | -0.1677 |
| alpha t-stat | 1.7119 | 1.8128 | 1.2351 | 1.4747 | -0.8171 | -1.1544 | 1.3048 | 1.3020 | -0.2313 | -1.4763 |
| beta | 0.6615 | 0.8128 | 1.0775 | 0.9545 | 1.1378 | 1.0891 | 0.9650 | 0.9455 | 1.6667 | 1.0648 |
| beta t-stat | 39.9891 | 20.0444 | 53.0597 | 57.6260 | 55.1217 | 42.8386 | 56.5171 | 40.6559 | 75.7470 | 50.7111 |

| GRS F-statistics | 1.8895 |
|---|---|
| p-value | 0.0028 |

### 0.1.3 c

For the following multivariate linear regression

$$r_{it} = \alpha_{ip} + \beta_{ip} r_{pt} + \varepsilon_{it}. \forall i = 1, ....., N.$$

The null hypothesis of the GRS test is

$$H_0 : \alpha_{ip} = 0, \forall i = 1, ....., N.$$

Here, we replace the $r_{pt}$ by market portfolio proxy $R_{Mt} - R_{ft}$ and do the time series regression:

$$R_{pt} - R_{ft} = a_i + \beta_{iM}(R_{Mt} - R_{ft}) + e_{it}. \forall i = 1, ....., 30.$$

Thus, the null hypothesis here is

$$H_0 : \alpha_i = 0, \forall i = 1, ....., 30.$$

Because we only use the market portfolio proxy as a factor here, we are testing whether this market portfolio proxy is the mean efficient portfolio when conducting GRS test. That's why this is a test of CAPM. The GRS test is a multivariate test of intercepts, which indicates how much each assets are mispriced by CAPM. It considers how much the intercepts are deviate from 0 weighted them on the inverse of residual covariance matrix. GRS compares the ex-post optimal Sharpe Ratio, or say distance to the market provided Sharpe ratio. It uses market portfolio proxy $R_{Mt} - R_{ft}$ as the estimate of beta risk premium.

### 0.1.4 d

Table below shows the intercepts of 30 time series regressions. We can tell from the table that the sign of intercepts are mostly positive and sometimes negative. The intercepts of games, books, txtls, cnctr, steel, fabpr, autos, coal, trans, whlsl, fin and other are negative. The magnitude of intercepts are between 0.0122

and 0.4822. As alpha t-statistics reported before show, the CAPM may have difficulty in pricing food, beer, smoke, hlth since the alpha t-statistics of them are bigger than 1.96, which is the critical value for 5% significance level.

| portfolio | food | beer | smoke | games | books | hshld | clths | hlth | chems | txtls |
|---|---|---|---|---|---|---|---|---|---|---|
| intercept | 0.2182 | 0.3171 | 0.4822 | -0.0591 | -0.0770 | 0.0578 | 0.1171 | 0.2553 | 0.1030 | -0.0173 |
| portfolio | cnstr | steel | fabpr | elceq | autos | carry | mines | coal | oil | util |
| intercept | -0.1024 | -0.2431 | -0.0360 | 0.0579 | -0.0122 | 0.0732 | 0.0427 | -0.0505 | 0.1850 | 0.0940 |
| portfolio | telcm | servs | buseq | paper | trans | whlsl | rtail | meals | fin | other |
| intercept | 0.1532 | 0.3976 | 0.1357 | 0.1321 | -0.0912 | -0.1587 | 0.1205 | 0.1638 | -0.0193 | -0.1677 |