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1. Construct long, short and arbitrage (long-short) portfolios. Test the statistical significance of the returns using the conventional t-test. Compute sharpe ratio for long portfolio. Is the sharpe ratios higher than that of the market portfolio?

The t statistics for long, short and arbitrage portfolios are 7.15, 2.97 and 3.55. Therefore, the t statistics showed that the average returns of these portfolios are all significant at 5% significance level. The computed sharpe ratio for long, short and arbitrage portfolios are 0.1678, 0.0512 and 0.06. And the computed sharpe ratio for market is 0.1238. Therefore, only the long portfolio's sharpe ratio is higher than that of the market portfolio.

2. Perform 4 regressions. Report the parameter estimates and test for their statistical significance using t test.

The estimated parameters for equation 1 are 0.0065 and -0.0346. T value for alpha is 3.657 and t value for beta is -1.0426. Therefore, the intercept is significant and the Rm – Rf factor is not significant.

The estimated parameters for equation 2 are 0.0065, -0.0179, -0.0991 and 0.0141. The T values showed that all the factors are not significant.

The estimated parameters for equation 3 are 0.0068, 0.0259, -0.0765, 0.0685, 0.00284, and – 0.05. None of these factors are statistically significant.

The estimated parameters for equation 4 are 0.005, 0.05, -0.0378, 0.13, 0.13, and – 0.05. None of these factors are statistically significant.

3. Buy 3 portfolios with lowst culmulative returns for past 5 years, sell 3 portfolios with highest culmulative returns for past 5 years. Is the excess return of the arbitrage portfolio significant? Do any of the regression models explain the excess return?

The excess return of the arbitrage portfolio is not statistically significant since the t value for it is -1.52 which is larger than the critical value at 5% significance level. None of the regression models explain the excess return.

Appendix: Code

```
% compute culmulative returns for j = 6 or 9
% sort portfolios by their culmulative returns
% compute average return for long, short and arbitrage
[nrows, ncols] = size(IndustryPortfolios);
Portfolio_Rets = IndustryPortfolios{:,2:ncols};


acc_rets = zeros(1117,30);
for i = 8:1124
    rets = ones(1,30);
    for j = 2:7
        rets = rets.*(1+Portfolio_Rets(i-j,1:30));
    end

acc_rets(i-7,:) = rets;
end
```

```
% compute t statistics for long, short and arbitrage portfolios' returns
t_long =
mean(Portfolio_Rets(:,31))/(std(Portfolio_Rets(:,31))/sqrt(length(Portfoli
o_Rets)));
t_short =
mean(Portfolio_Rets(:,32))/(std(Portfolio_Rets(:,32))/sqrt(length(Portfoli
o_Rets)));
t_arbitrage =
mean(Portfolio_Rets(:,33))/(std(Portfolio_Rets(:,33))/sqrt(length(Portfoli
o_Rets)));


% regress on Rmkt - Rf
x = FFResearchDataFactors{:,"MktRF"} * 0.01;
y = Portfolio_Rets(:,33);
n_rows = length(x);
x = [ones(n_rows,1) x];
params = inv(x.'*x)*x.'*y;
```

```
% Regress on three factors
x = FFResearchDataFactors{:,2:4} * 0.01;
y = Portfolio_Rets(:,33);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_3_factor = inv(x.'*x)*x.'*y;
```

```
% Regress on five factors
x = FFResearchData5Factors2x3{:,2:6}*0.01;
y = Portfolio_Rets(445:1124,33);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_5_factor = inv(x.'*x)*x.'*y;
```

```
% Regress on q factors
x = [Dataqfactors{:,"R_MKT"}-Dataqfactors{:,"R_F"}
Dataqfactors{:,5:7}]*0.01;
y = Portfolio_Rets(487:1122,33);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_q_factor = inv(x.'*x)*x.'*y;
```

3.

```
[nrows, ncols] = size(Portfolios5x5);
Portfolio_25 = Portfolios5x5{:,2:ncols};


acc_rets_25 = zeros(1118,25);
for i = 7:1124
    rets = ones(1,25);
    for j = 2:6
        rets = rets.*(1+Portfolio_25(i-j,1:25));
    end

    actual_rets = Portfolio_25(i-1,:);
    acc_rets_25(i-6,:) = rets;
end
```

```
% compute t statistics for long, short and arbitrage portfolios' returns
t_arbitrage_25 =
mean(Portfolio_25(:,28))/(std(Portfolio_25(:,28))/sqrt(length(Portfolio_25
)));
```

```
% regress on Rmkt - Rf
x = FFResearchDataFactors{:,"MktRF"} * 0.01;
```

```
y = Portfolio_25(:,28);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_25 = inv(x.'*x)*x.'*y;
```

```
% Regress on three factors
x = FFResearchDataFactors{:,2:4} * 0.01;
y = Portfolio_25(:,28);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_3_factor_25 = inv(x.'*x)*x.'*y;
```

```
% Regress on five factors
x = FFResearchData5Factors2x3{:,2:6}*0.01;
y = Portfolio_25(445:1124,28);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_5_factor_25 = inv(x.'*x)*x.'*y;
```

```
% Regress on q factors
x = [Dataqfactors{:,"R_MKT"}-Dataqfactors{:,"R_F"}
Dataqfactors{:,5:7}]*0.01;
y = Portfolio_25(487:1122,28);
n_rows = length(x);
x = [ones(n_rows,1) x];
params_q_factor_25 = inv(x.'*x)*x.'*y;
```