

Directions

You may work on this homework in groups of up to four people. Show your work at a reasonable level of detail. Answers should be typed (or printed legibly) and are due as stated in the syllabus at the beginning of class. Turn in only one set of answers per group. Your submission should include two coversheets with the following information in large type: the assignment name, class and section number, the names of all group members. The two coversheets are to ensure the privacy of your grade when assignments are returned.

Spreadsheet

For all the questions you will need to download the accompanying spreadsheet.

- Page one of the spreadsheet contains a tool for calculating the weights of the tangency portfolio for six assets. You will only edit the yellow areas. You must enter the risk free rate, gross mean vector and the covariance matrix. The sheet will calculate the excess returns for you. The red block shows the tangency weights.
- Page two of the spreadsheet contains data you will need for the assignment. The data is monthly returns for approximately the last 20 years. There are six columns of gross returns on the six Fama French size and book-to-market portfolios. Next there are four columns consisting of the excess market return, the return on the two Fama French factors and finally the return on the risk free asset.

Question 1:

You are to construct the optimal portfolio (tangency portfolio) of the six Fama French portfolios with the help of the CAPM. You can think of each portfolio as a single risky asset.

- Step 1: Run the regressions necessary to calculate the alphas and betas relative to the market return for each of the Fama French portfolios. The regression equation is

$$r_{i,t}^e = \alpha_i + \beta_i * r_{mkt,t}^e + \epsilon_{i,t}$$

Report your regression results in a table. Each column of the table should be the results of a regression on an individual portfolio. The rows of the table should be in

this order: the portfolio name, the alpha, the alpha t-stat, the beta, the beta t-stat, the R^2 .

- Step 2: Calculate the covariance matrix implied by the CAPM. (Remember you need calculate the market variance from the market return and the variance of each asset directly from the data.)
- Step 3: Calculate the actual mean return of each portfolio (i.e. with the alpha) and calculate mean return of each portfolio implied by the CAPM (i.e. without the alphas).
- Step 4: Using the tool provided and the covariance matrix and mean vectors you have calculated, find the optimal portfolio of the portfolios (i.e. the weights in the tangency portfolio thinking of each of the six portfolios as individual risky assets). *In the tool you are entering vectors of excess return already so you should set the risk free rate to zero.* You will calculate two such portfolios: one using the mean vector of actual returns and one using the mean vector implied by the CAPM. Report the weights.

Question 2:

In this question you will compare how well the CAPM works versus the Fama French 3-factor model.

- Step 1: Plot the CAPM betas versus actual *excess* returns for the six portfolios. You calculated this data in question 1. Do you see the results the CAPM predicts?
- Step 2: Run the regression necessary to produce the alphas and loadings for the Fama French 3 factor model for each portfolio. The regression equation is

$$r_{i,t}^e = \alpha_i + b_i * r_{mkt,t}^e + s_i * r_{SMB,t} + h_i * r_{HML,t} + \epsilon_{i,t}$$

Report your results in table similar to the one from question 1, but now you will have more rows for the additional factors.

- Step 3: Compare the alphas of the CAPM versus those of the Fama French 3 factor model. Make a table of the alphas for each asset from each model side by side. In the last row of the table, calculate the mean absolute alpha for each model. (This means you average the absolute value of the alphas.) Which model has bigger alphas?
- Step 4: Since there are multiple factors and loadings we can no longer plot actual mean return versus beta. Instead to see how well the Fama French 3 factor model does we can plot expected mean returns under the model versus actual mean returns for each portfolio. To calculate the predicted returns you multiply the factor loadings you

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calculate for each asset (portfolio) times the average return on the factor (just like you did for the CAPM with the market and beta but now you have more factors) and sum the products:

$$E[r_i^e] = b_i E[r_{mkt}^e] + s_i E[r_{SMB}] + h_i E[r_{HML}].$$

The plot should have expected returns on the x-axis and actual returns on the y-axis. If the model is a good fit the points will lie close to the 45-degree line originating at the origin.

- Step 5: Which model do you feel fits this data better and why?