ECON 433 - Homework #3 due on 2021/10/21

In this assignment, we test the CAPM and implement the Fama-French 3 factors approach using the monthly returns of 100 value weighted portfolios formed on size and investment as our "test assets" over the last 40 years - that is from 1981-09 to 2021-08.
Download the data from Ken French website[1]. You will also need the corresponding series of stock returns you studied in Homework #2.

1. Portfolios:

   (a) How are our test portfolios built? How can we understand/interpret them?

   (b) Why are we using portfolios as our test assets instead of using 100 actual stocks?

   (c) You may notice that there are two sets of portfolio returns formed on size and investment: at the top of the file, they are value weighted (the ones we are using); and if you scroll down, others that are equal-weighted. What is the difference between these two types of portfolios?

2. CAPM:

   - Recall the CAPM 2-step approach:
     - Step 1: for each portfolio i, run the following (time series) regression

       $$R_{i,t} = \alpha_i + \beta_{i,M} Mkt_t + \epsilon_{i,t}$$

       Here we consider stock returns and market returns (another possibility would be stock excess returns and market excess returns). Keep the OLS estimate of the slope coefficient $\beta_{i,M}$, as well as the sample average of the returns as well (e.g. $\overline{R}_i = \sum_t R_{i,t}/T$).
       You will need to implement a "For" loop in R, create the appropriate storage matrix where you will collect all quantities needed to implement the second step.
     - Step 2: run the following (cross-section) regression

       $$\overline{R}_i = \alpha + \lambda_M \hat{\beta}_{i,M} + e_i$$

       and estimate the market risk premium λ_M and the intercept α by OLS.

   (a) CAPM on your chosen stock.

      i. Estimate the Step 1 model using the series of stock returns you studied in Homework #2.

[1] `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`

ii. Report 95% confidence intervals for intercept and slope coefficients.

iii. Is α statistically significantly different from 0?

iv. Conduct a one-sided test[2] on β to test whether it is equal to 1 or not. Conclude whether your stock is as risky as the market.

(b) Testing the CAPM using the portfolios.

i. Implement the CAPM 2-step approach over the entire sample.

ii. Interpret the results of Step 2.

iii. Run diagnostic checks on the residuals of Step 2. Comment.

iv. Overall, would you say the CAPM is a suitable model or not?

3. Fama-French 3 factors approach.

(a) Implement the Fama-French 2-stage approach over the entire sample and interpret the results (e.g. are the risk premia significantly different from zero, their signs...).

- Recall the FF 2-stage approach:
  - Step 1: for each portfolio i, run the following (time series) regression

$$R_{i,t} = \alpha_i + \beta_{i,M} Mkt_t^e + \beta_{i,S} SMB_t + \beta_{i,V} HML_t + \epsilon_{i,t}$$

    The 3 factors are the market excess return, SMB and HML. Keep the OLS estimates of the above beta coefficients as well as the sample mean of the returns.
  - Step 2: run the following (cross-section) regression

$$\overline{R}_i = \alpha + \lambda_M \hat{\beta}_{i,M} + \lambda_S \hat{\beta}_{i,V} + \lambda_V \hat{\beta}_{i,V} + e_i$$

    and estimate the risk premia by OLS.

(b) To address some concerns regarding the stability of the model parameters over such a long sample period of 40 years, we redo the analysis over five subsamples of 8 years that are non-overlapping: from 1981-09 to 1989-08; from 1989-09 to 1997-08; ...

Ideally, you want to implement a "double For Loop" with 2 indices: the "outside" index that tracks down the subsample; the "inside" index that tracks down the 100 portfolios. Note: the inside loop is the same as the for loop implemented over the entire sample. Don't forget to store the needed quantities! If the double for loop is too much, I will also accept doing the analysis "by hand" 5 times over each subsample.

[2]The direction of the test depends on the estimated slope coefficient: e.g. if the estimated beta is above 1, then the test will be: $H_0 : \beta = 1$ vs $H_1 : \beta > 1$; if the estimated beta is below 1, then the test will be: $H_0 : \beta = 1$ vs $H_1 : \beta < 1$.

i. 1st stage results. It is difficult to analyze the 1st stage results because there are 100 sets of results for each subsample! We focus on the results of the following 3 portfolios: the first one labelled "SMALL LoINV", the 50th labelled "ME5 INV10", and the last one "BIG HiINV". For each portfolio, produce 1 graph that shows the evolution of the estimated betas (3 curves: 1 for each factor) over time: x-axis for the subsamples and y-axis for the estimated betas with confidence interval.

   What can you conclude? Are the betas time-varying or not?

ii. Discuss the results of the second stage about the risk premia and compare them with the results obtained over the whole sample. Present your second stage results on 3 graphs for better readability: x-axis for the subsamples and y-axis for the estimated risk premia with confidence interval [3 graphs: 1 for each factor and associated risk premium].

   What can you conclude? Are the risk premia time-varying or not?