Assignment 3, ECON 270

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Download the Excel file 'FFFactors_2006.xls' from the course web page. This file has monthly returns on the risk-free rate Rf (as a monthly rate) and the Fama-French factors: excess returns on the stock market (MKT-RF), the return on a portfolio that is long in small caps and short in large-caps (Small minus big, SMB) and the return on a portfolio that is long in value stocks or high book-to-market and short in growth stocks, or low book-to-market (high minus low, HML). We also provide data on 10 size-sorted and 10 book-to-market ratio sorted value-weighted portfolios (so-called decile portfolios). The data runs from 1926:07 - 2006:07.

1 GMM Test of CAPM

Using the GMM methodology discussed in class, use the full data sample (1926-2006) to test whether the CAPM restrictions

$$\mathbf{R}_t = \boldsymbol{\alpha} + \boldsymbol{\beta} R_{mt} + \boldsymbol{\varepsilon}_t,$$

hold when you estimate the model simultaneously on the 20 size-sorted and book-to-market sorted portfolios. Use the (Mkt-Rf) column in the FFFactors worksheet as R_{mt} and subtract the risk-free rate from the size and B/M portfolios to get excess returns. The null is that $\boldsymbol{\alpha} = \mathbf{0}$. Is the outcome of the test sensitive to how many portfolios you use (i.e. instead of using 20 portfolios, try using the first, fifth and tenth of the size and B/M portfolios so you get a total of six portfolios)?

2 Mean-Variance Efficient Frontier and Risk Premia

Using the returns on the 10 size sorted portfolios,

(i) Construct and plot the efficient frontier

(ii) Derive and report the weights on the tangency portfolio. How large is this portfolio's Sharpe ratio? You can assume that the risk-free rate takes a value equal to its sample mean (computed over the full data set).

Next, you want to use a simple IID bootstrap to draw rows of the returns data with replacement. To do so, draw (with replacement) each of the 961 time-periods in the sample with the same probability, collect the corresponding 10 portfolio returns. Do this 961 times so you get a new 961x10 matrix of returns, R^b, for the bth bootstrap. Compute the maximum Sharpe ratio (assuming a fixed interest rate of 0.3% per month) for the associated tangency portfolio on the efficient frontier and store this value. Repeat this 1,000 times.

(iii) Based on the bootstrap results, construct a 95% confidence interval for the Sharpe ratio. You can do this by ranking the 1000 bootstrapped Sharpe ratios and then selecting the 2.5% and 97.5% quantiles from this distribution.

(iv) Suppose you only use data from 1926-1965:12 to estimate the weights on the portfolio with the highest Sharpe ratio (in-sample). How well did this portfolio perform (as measured by its Sharpe ratio) in the subsequent out-of-sample period 1966:1 - 2006:07 compared to, say, an equal-weighted portfolio of the 10 size-sorted portfolios?

Next, split the data set into two halves, again using 1965:12 as the dividing point. Use the first sub-sample (pre-1966) to estimate the betas for the individual size portfolios from time-series regressions

$$r_{it} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + \varepsilon_{it}, \quad i = 1, ..., 10,$$

where r_{mt} is the excess return on the market (Mkt-Rf) and r_{ft} is the risk-free T-bill rate. For each stock, i, this gives you an estimate $\widehat{\beta}_i$.

Keep the above beta estimates fixed in the following exercise: for each period t = 1966:1,..., 2006:07, estimate a cross-sectional regression

$$r_{it} = \lambda + \gamma_t \widehat{\beta}_i + \varepsilon_t, \quad i = 1, ..., 10$$

Save the regression coefficients $(\widehat{\gamma}_{1966:01}, ..., \widehat{\gamma}_{2006:07})$.

(v) Treating the $\widehat{\gamma}_t$-estimates as a time series, determine whether beta risk is priced in this sample. Discuss your findings.

(vi) Suppose that, in place of the market index, you used instead the mean-variance efficient portfolio from (ii) as your market index in the full-sample regression of mean excess returns on beta estimates computed with respect to this portfolio. How good will this fit be? Verify your answer empirically.

3 Fama-French Portfolios - Economic Interpretation

In the lectures we discussed two famous anomalies (small cap stocks and value stocks outperformed other stocks historically, even after adjusting for risk). Dimensional Fund Advisors (DFA) is a Santa Monica, CA firm that was set up as an investment vehicle to exploit these anomalies. In the early 1980s DFA created a small-cap fund while at the beginning of the 1990s a value fund was created.

This exercise asks you to analyze DFA's investment strategy. To this end return to the FFFactors_2006.xls data set.

1. Using data up to 1981, estimate the alphas of the size-sorted portfolios in a simple CAPM regression of excess returns on the size-sorted portfolios on an intercept and the excess return on the market. What do you find? As a fund manager, what opportunities do you see?

2. Can you reject the CAPM based on these results? Conduct a formal test and report the p-value that you get.

3. Repeat the analysis for the book-to-market portfolios in 1990. What do you now find?

4. What happened to the size effect after 1981 and to the book-to-market effect after 1990?

5. Using what you know about finance, discuss whether the returns to small-caps and high book-to-market firms are

(i) A "good deal" (the result of market mispricing possibly due to irrational investors);

(ii) "Compensation for risk" (in the sense of the CAPM or the APT); or

(iii) A "statistical fluke" (resulting from a short sample or the use of incorrect statistical methods)