Mgmt 237E: Empirical Methods in Finance
Homework 6

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Please use Matlab/R to solve these problems. You can just hand in one set of solutions that has all the names of the contributing students on it in each group. The problem set is due on February 22 by 9:45 AM. Use the electronic drop box to submit your answers. Submit the Matlab or R file and the file with a short write-up of your answers separately.

[The quality of the write-up matters for your grade. Please imagine that you're writing a report for your boss at Goldman when drafting answers these questions. Try to be clear and precise.]

Portfolio Sorts Revisited

Last class there seemed to be some remaining confusion about portfolio sorts. This question gives the simplest illustration possible of a portfolio sort procedure. In particular, we will consider a momentum-type sort. You are given the following time-series of four stocks' annual excess returns:

Year	Stock A	Stock B	Stock C	Stock D
2012	−12%	29%	15%	−3%
2013	−3%	15%	3%	5%
2014	7%	5%	−10%	25%
2015	−6%	−1%	3%	10%
2016	33%	−29%	8%	−18%

The average excess return to each of these four stocks equals 3.8%. Thus, any portfolio put together using these four stocks that has constant portfolio weights over time will have an average return of 3.8%. However, we will construct portfolios where the portfolio weights are changing over time, taking advantage of a return forecasting signal (characteristic). In particular, we will consider a momentum strategy where the signal is last year's return.

1. Create 2-quantile equal-weighted portfolios sorted on last year's return. This bears further explanation: instead of the usual decile sort, which we cannot do for obvious reasons, sort stocks into two portfolios where the breakpoint is the median of last year's return. Since we have only four stocks, the median is not uniquely defined. We need an additional rule: let's define the "effective median" as the average of the two median returns.

   In 2012, this "effective median" is $(-3\% + 15\%)/2 = 6\%$. Thus, we sort stocks into a winner portfolio (last year return greater than 6%), and a loser portfolio (last year's return smaller than 6%). That means for this year stocks A and D are in the loser portfolio, while stocks B and C are in the winner portfolio. Calculate the return to each of these portfolios for the next year. You should get that the loser portfolio has an excess return of 1% and the winner portfolio has an excess return of 9% in 2013.

   At the very end of 2013 (or very beginning of 2014), re-sort stocks into the new loser and winner portfolios based on their 2013 returns, calculate the portfolio returns for 2014, and continue in this fashion until you have a complete time-series of returns for the loser and winner portfolios from 2013 through 2016.

   (a) Report the returns to these portfolios in each year, report what stocks are in each portfolio each year, and report the average return to each portfolio.

   (b) Do you find the expected momentum result? You should. Note that this occurs due to the portfolio sorting alone using the momentum signal. In particular, assume the market portfolio weights are constant each year and equal to 0.3 (stock A), 0.2 (stock B), 0.353 (stock C), 0.147 (stock D) and report the average market returns.

   (c) Create the long-short momentum portfolio (each year long the winner portfolio and short the loser portfolio). Report the time series of its returns, the average long-short returns, and the correlation with market returns. Given these numbers,

does the CAPM hold in this market (base your conclusion on point estimates, not statistical significance; there are too few observations to get any of the latter).

2. Now instead create quartile sorts based on the momentum signal. That is, create four portfolios (loser, semi-loser, semi-winner, and winner). Since we only have four stocks, that simply means one stock in each 'portfolio.'

   (a) Report the time-series of each of the four portfolios' returns from 2013 through 2016, as well as the average return. Do you get the expected momentum-sorted portfolio return result?

   You should not. In this case, you do not get the expected momentum result in that average returns are not monotonically related to the momentum signal. However, this may be a reflection of each individual stock's average being too noisy due to idiosyncratic shocks. Sorting into portfolios (as you did in (1)) reduces the idiosyncratic noise and reveals the common component (the predictable component based on lagged returns), which is a high expected return for past winners and low expected return for past losers. This reduction of idiosyncratic noise is why we sort into portfolios, such as the typical decile portfolio sorts. This is also an underlying reason for why the Fama-MacBeth regression finds it optimal to create a portfolio return and then uses its average return as the price of risk estimate.

AR(p) Processes

3. Consider an AR(2) process with $\phi_1 = 1.1$ and $\phi_2 = -0.25$ (following the notation in Lecture 10).

   (a) Plot the autocorrelation function for this process for lags 0 through 20.

   (b) Is the process stationary? Explain why or why not.

   (c) Give the dynamic multiplier for a shock that occurred 6 periods ago. That is, calculate $\frac{\partial[r_{t+6}-\mu]}{\partial \varepsilon_t}$ (following the notation in Lecture 10).

   (d) Now, instead assume $\phi_1 = 0.9$ and $\phi_2 = 0.8$. Give the dynamic multiplier for a shock that occurred 6 periods ago. Is the process stationary? Why/why not?