FE5206 Final Assignment, Due: Wednesday, 22 November 2023

Submit your answers to Canvas. Word and PDF files are acceptable. Please include your name (family name first) at the beginning of the filename.

Part A

You will const[illegible]ctors: V and M for the US market. V is based on [illegible] returns and M is the MAX factor discussed in the lectur[illegible] construct factor V are the same as in Assignment 2 (except that the order of steps c and d are interchanged). For simplicity, ranking is not used to construct V and M.

1. Consider the US market and the years 2004 to 2023 (you will also need some data in 2003 to calculate the alpha factor). The universe used for each year will be based on the universe from the start of the year (defined in the univ_h.csv file).

2. To construct factor V
   a) calculate the daily volatility $\sigma_i(t)$ using the prior 21 days of daily returns (use the log return $r_i(t') = \ln\left(\frac{p_i(t')}{p_i(t'-1)}\right), t' = t-20, \dots, t$, the return is set to 0 if there is an "NA" in the adjusted prices). If $\sigma_i(t)$ obtained is less than 0.005, set it to 0.005.
   b) calculate the prior 10-day return; you can use the log-return $v_i(t) = \ln\left(\frac{p_i(t)}{p_i(t-10)}\right)$ (again, the return is set to 0 if the price is not available)
   c) normalize the variable by dividing the volatility $\sigma_i(t)$ obtained in step a), $v_i(t) \leftarrow v_i(t)/\sigma_i(t)$
   d) subtract out the market average $v_M(t) = \frac{1}{N}\sum_{i=1}^{N} v_i(t)$ (N is the number of stocks in the universe for the year), $v_i(t) \leftarrow v_i(t) - v_M(t)$

3. To construct factor M
   a) Use the daily returns for the past 21 trading days, $r_i(t') = \ln\left(\frac{p_i(t')}{p_i(t'-1)}\right), t' = t-20, \dots, t$, calculated in Step 2a).
   b) subtract out the corresponding market returns (calculated using a simple average): $R_i(t') = r_i(t') - r_M(t'), t' = t-20, \dots, t$
   c) get the maximum value, $m_i(t)$, of the magnitudes of the prior 21 daily returns, $|R_i(t')|, t' = t-20, \dots, t$. The normalization by the volatility is not applied to this factor.

d) subtract out the market average $m_M(t) = \frac{1}{N}\sum_{i=1}^{N} m_i(t)$, $m_i(t) \leftarrow m_i(t) - m_M(t)$

4. Do a cross[illegible]sion of the next day's return $R_i(t+1) \equiv R_i(t, t+1)$ [illegible]

$$[illegible]_i(t) + \beta_m(t) m_i(t) + \epsilon_i, \qquad i = 1, \dots, N$$

on day t a[illegible]eries of $\beta_v(t)$ and $\beta_m(t)$. Here $R_i(t+1)$ is defined as [illegible] $1) - r_M(t+1)$,

where $r_i(t+1) = \ln\left(\frac{p_i(t+1)}{p_i(t)}\right)$ and the market return $r_M(t+1)$ is the simple average of $r_i(t+1)$.

5. From the years 2005 to 2023, calculate the 2-year average of $\beta_u(t), \beta_v(t)$, and the t-stat, $\sqrt{T}\frac{\overline{\beta_v}}{\sigma_{\beta v}}$ *and* $\sqrt{T}\frac{\overline{\beta_m}}{\sigma_{\beta m}}$, where T is the number of trading days in the year and the year before (for example, the average obtained for the year 2005 is over the years 2004 and 2005; for the year 2023 the average is over one and half years as there is only half year data in 2023) and $\sigma_{\beta v}$ and $\sigma_{\beta m}$ are the standard deviation of $\beta_u(t), \beta_v(t)$ calculated using $\beta_u(t), \beta_v(t)$ in these two-year periods. List the two-year average betas and the t-stat obtained in a table.

Part B

From the years 2006 to 2023, use the two-year average $\overline{\beta_v}$, $\overline{\beta_m}$ calculated (in Part A) from the previous year (for example, for the year 2006, use the 2-year average obtained in 2005 in Part A) and evaluate the expected returns for the year,

$$R_{Ei}(t, t+1) = \overline{\beta_v} v_i(t) + \overline{\beta_m}\, m_i(t)$$

Construct and evaluate the portfolio as follows,

1. On each day t, rank the stocks according to the expected returns, and long (with equal weights) the top 20% of the stocks with the largest values of $R_{Ei}(t, t+1)$ and short the bottom 20% of the stocks with the smallest values (most negative values) of $R_{Ei}(t, t+1)$
2. Get the portfolio return at each time step t. The return is on the long market value of the portfolio, so it is the sum of the returns on individual positions divided by the number of long positions in the portfolio,

$$r_p(t, t+1) = \frac{1}{N_l}\left(\sum_{j=1}^{N_l} r_{L(j)}(t, t+1) - \sum_{j=1}^{N_s} r_{S(j)}(t, t+1)\right),$$

where N_l and N_s are the number of long and short positions (both are equal to $0.2 \times N$, N is the number of stocks in the universe for that year). $L(j)$ is the stock index of the long position j. $S(j)$ is the stock index of the short position j. Note that when calculating the portfolio return, the full return $r_i(t+1) \equiv r_i(t, t+1)$ without subtractin[illegible]urn is used.

3. For each y[illegible] total annual return (assuming the cost of trading is [illegible]l return volatility of the portfolio. Which are the be[illegible] years for the strategy?

Part C (optional)

Assume that the percentage trading cost is 5 bps and calculate the portfolio returns, taking into account the cost. Compare the results to the case when the costs are not taken into account (obtained in Part B). For simplicity, we assume the LMV (the long market value) of the portfolio is kept the same and we ignore the cost of maintaining the constant LMV.

Part D

Your reflections on the group project and the course: Briefly describe a) How do you contribute to the project? b) What difficulty, if any, have you encountered in doing the project and studying for the course? c) Which topic of quant investment is most interesting to you? d) Which topic is the most difficult to understand?