IB9KC0: Financial Econometrics

University of Warwick, Warwick Business School

Guidelines

All questions can be solved using any programming language of your choice. It is recommended you stick to Matlab given the seminar material, however the questions can also be done via Python or R if that is your preferred language. Soft copies of your written answers and codes must be submitted via MYWBS by 8pm March 23th. Codes should be commented and be able to execute to generate the results.

All results must be interpreted: Half of the work in the project is doing the computations. The other half of the work is interpreting the results. You must interpret results regardless of whether the exercise explicitly asked for it or not.

All plots in the report must be self-contained. Self-contained means that a reader who only sees your figure (image and caption, but not the surrounding text) can understand what you are plotting. This translates to all plots having axis titles, correct units on the axis, and a caption that summarizes what is plotted.

If you need to separate diffusive from jump returns, use the value $\alpha = 4.5$.

Whenever asked to fill a "Summary Statistics" table, there is no need to convert the units (use the raw value of the statistic).

Part I [30 marks]

A long-short hedge fund follows a trading strategy defined by a long (buy) position in one stock and a short (sell) position in the other. The idea is that the fund has identified positive future prospects for the stock held long and negative future prospects for the stock that is shorted. The rules of short trading are set up so that the return on the short stock is just the negative of the return if it were held long. Let $r_{t,i}^{A}$ denote the return on stock A (long) at day t over the i-th interval, and $r_{t,i}^{B}$ denote the return on stock B (short). Then, the return on the long-short portfolio is just:

$$r_{t,i}^{\text{Long-Short}} = r_{t,i}^{A} - r_{t,i}^{B}$$

Usually, hedge funds charge investors rather large fees, and investors thereby demand that the fund demonstrate that its strategy is market neutral. A market neutral strategy is a strategy that provides returns that have zero beta with the market. The reason investors demand a market neutral strategy is that investors can easily (and cheaply) earn the average market return by using a mutual fund or ETF that tracks the market index. Therefore, there is no point in paying the hedge fund the fees for the market return.

For this exercise you will also use data on the market index (SPY). If one of your stocks already is SPY, pick a different one from the available stocks and clearly state what stock you are using.

A.[2 marks]: Compute the long-short 5-min returns (long on stock 1, short on stock 2) for your two stocks across all days. Fill out the summary statistics table below for the diffusive returns of your long-short portfolio:

Summary Statistics of Long-Short Continuous Returns				
Average	Min	5% Percentile	95% Percentile	Max

B.[4 marks]: Estimate the realized beta between your long-short portfolio and the market index (SPY). Fill the table below:

Summary Statistics of the Realized Beta				
Average	Min	5% Percentile	95% Percentile	Max

C.[**8 marks**]: Compute 95% confidence intervals for the realized beta. Use $k_n = 11$ and 1000 repetitions to keep the computations doable. Plot the entire trajectory of the realized beta and intervals in a suitable way to show an investor. Comment on whether at least visually the long-short position appears market neutral.

D.[**8 marks**]: Plot the realized beta and 95% confidence intervals for October, 2008 (be careful with the x-axis, only plot the business days in October). Interpret the results.

E.[**8 marks**]: Most investors demand more than just a plot and insist on formal statistical tests. We can test the null hypothesis of zero beta at the 5 percent level by checking whether a 95 percent confidence includes zero or not. That is, we reject the null hypothesis if zero does not lie in the 95 percent confidence interval. Run the test day-by-day for your data set and compute the average number of rejections over all the days in your data set. Report the total number of rejections. A common rule is to declare a hedge fund **not** market neutral if there are 10 percent or more rejections. (Five percent would be expected by simple statistical fluctuations so the 10 percent rule adds in a small additional allowance.) Would the hedge fund holding long stock 1 and short stock 2 be considered market neutral?

Part II [30 marks]

Consider

$$r^c_{1,t,i} = \text{continuous returns of stock 1}$$

$$r^c_{2,t,i} = \text{continuous returns of stock 2}$$

$$r^c_{m,t,i} = \text{continuous returns of SPY}$$

A.[**2 marks**]: Obtain the continuous returns above. Complete the table below:

Summary Statistics for Continuous Returns

Stock	Average	Min	5% Percentile	95% Percentile	Max
1					
2					
SPY					

B.[**2 marks**]: How many jumps did you detect in the market?

C.[2 marks]: Estimate the realized betas for both stocks, and fill the table below:

Summary Statistics of the Realized Beta					
Stock	Average	Min	5% Percentile	95% Percentile	Max
1					
2					

D.[2 marks]: Plot the realized betas of both stocks. From viewing the plot, would you say that your stocks generally more risky than the market ($\beta > 1$), less risky than the market ($\beta < 1$), or as risky as the market ($\beta = 1$)?

E.[4 marks]: The residual (non-market) part of the returns on the stocks are:

$$e_{1,t,i} = r^c_{1,t,i} - R\beta_{1,t} r^c_{m,t,i}$$

$$e_{2,t,i} = r^c_{2,t,i} - R\beta_{2,t} r^c_{m,t,i}$$

The residual stock returns can be correlated because of common factors other than the market. The realized correlation between the residuals is denoted by:

$$\rho_{e,t} = \text{Correlation between } e_1 \text{ and } e_2 \text{ on day } t$$

The correlation $\rho_{e,t}$ between the residuals is the simple correlation between the residuals over the day (Matlab function **corr**). Compute the correlation day by day and fill the below:

Summary Statistics of the Residual Correlation				
Average	Min	5% Percentile	95% Percentile	Max

F.[8 marks]: Compute 95% confidence intervals for the realized correlation between the residuals using the bootstrap method (with $k_n = 11$ and 1000 repetitions). Plot the correlations and confidence intervals. Interpret the results.

G.[5 marks]: Plot the correlation and 95% confidence intervals for October 2008 (be careful with the x-axis, only plot the business days in October). Interpret the results.

H.[5 marks]: Consider the null hypothesis $H_0 : \rho_{e,t} = 0$ versus the alternative $H_1 : \rho_{e,t} \neq 0$. Use your confidence intervals to compute the following proportions:

$$p_0 = \frac{\text{number of days do not reject } H_0 : \rho_{e,t} = 0}{252}$$

$$p_+ = \frac{\text{number of days reject } H_0 : \rho_{e,t} = 0 \text{ in favor of } \rho_{e,t} > 0}{252}$$

$$p_- = \frac{\text{number of days reject } H_0 : \rho_{e,t} = 0 \text{ in favor of } \rho_{e,t} < 0}{252}$$

Report the numbers and interpret the results.

Part III [30 marks]

Some would argue that the beta is different for up moves than down moves in the market. We would write this as

$$\Delta Y_{t_p} = \beta^+ (\Delta Z_{t_p})_+ + \beta^- (\Delta Z_{t_p})_- \tag{1}$$

The above is the multiple regression version of jump regression.

A.[15 marks] Sketch the asymptotic distribution theory for the multiple regression version of jump regression under the same assumptions as in the class notes. This only requires you to be careful about vectors versus scalars in the notation.

B.[15 marks] For the full sample, estimate the model (1) for each stock. Is there evidence against the hypothesis $\beta^+ = \beta^-$?