Mgmt 237e: Homework 2
Autocorrelation

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Please use Matlab or R to solve these problems. If you used R for the previous one, use Matlab for this one. And vice-versa. The problem set is due on January 19. Use the electronic drop box to submit your answers. Submit the Matlab/R file and the file with a short write-up of your answers.

Problem 1: Measuring uncertainty in Hedge Fund strategies: bootstrapping

The spreadsheet *datahwk2_problem1.xlsx* contains the returns on 8 different hedge fund strategies.

1. Estimate the mean return for each of these categories.

2. Use the nonparametric (*i.i.d.*) bootstrap to calculate standard errors. Use $B = 10,000$ bootstrap samples.

3. Compute and plot the autocorrelations up to lag 12 for the returns of the DJ CS index for each of the Hedge Fund Categories. Use the longest sample of monthly returns available for each index.

4. Test the null that the first 12 autocorrelations of monthly returns are zero for each of these Hedge Fund Categories using the Ljung and Box (1978) test.

5. The paper by Getmanski, Lo, and Makarov (2004) argues that a significant lag 1 autocorrelation is indicative of exposure to liquidity risk, see also Khandani and Lo (2011).[1] Assess the liquidity of these investment strategies based on these findings. Use the returns on the CRSP-VW stock market index as a benchmark.

[1] You do not need to go read these papers to complete the assignment. However, I list the papers as suggestive.

6. How might these findings influence your decision to use the nonparametric (*i.i.d.*) bootstrap? Is the nonparametric (*i.i.d.*) bootstrap still appropriate? Explain.

7. Optional: Implement the block bootstrap.[2] How do your results change?

[2] In R, there is a function 'tsboot' while in Matlab you can download Kevin Sheppard's MFE toolbox. You can find this via Google search. He has a function called 'block_bootstrap.m'

Problem 2: Linear Hedge Fund Clones

The spreadsheet *datahwk2_problem2.xlsx* contains six different factors.

$BOND$ is the return on the USA AAA Corporate Bond Index, $CREDIT$ is the return on the Dow Jones Corporate Bond Index minus the return on the Lehman Treasury index, $DOLLAR$ is the return on a broad-based currency index, SP500 is the return on the S&P 500 and $CMDTY$ is the return on the Goldman Sachs Commodity Price Index. Finally $DVIX$ is the first difference in the VIX volatility index. These are all returns on liquid instruments.

Hedge funds are opaque (they do not tell you what they are doing) and they often hold assets with a lot of liquidity risk. The point of this question is to replicate the returns on a given strategy using highly liquid instruments that may be cheaper to trade and not exposed to liquidity risk; see Hasanhodzic and Lo (2007) and Khandani and Lo (2011). In other words, can we achieve similar performance without excessive liquidity risk? The idea of replicating a return is called a **replicating strategy** and the portfolio is a clone.

1. Clone: Compute a linear clone for each of the hedge fund categories from Question #1 above by regressing the returns on 5 of the 6 factors in the 'factors' worksheet. However, we do not include a constant in the regression, and we impose the constraint that the factor loadings sum to one. The linear regression model is given by:

   $$R_{it} = \beta_{i,1}SP500_t + \beta_{i,2}BOND_t + \beta_{i,3}USD_t + \beta_{i,4}CREDIT_t + \beta_{i,5}CMDTY_t + \varepsilon_{i,t}$$

   To estimate the factor loadings, we minimize the sum of squared residuals subject to this linear constraint on the loadings :

   $$\sum_{j=1}^{5} \beta_{i,j} = 1$$

   (Hint: use the lsqlin command in Matlab)[3]

   We use $R^{\star}_{i,t}$ to denote the return on the clone:

   $$R^{\star}_{it} = \beta_{i,1}SP500_t + \beta_{i,2}BOND_t + \beta_{i,3}USD_t + \beta_{i,4}CREDIT_t + \beta_{i,5}CMDTY_t$$

2. Leverage: Define a version of the cloned strategy with the same volatility as the actual hedge

[3] This constraint allows us to interpret the loadings as portfolio weights in the linear cloning strategy. In addition, not including a constant forces the algorithm to use the mean of the factors to match the mean returns. Following Andrew Lo, we leave out $DVIX$ but you can try the same exercise while including $DVIX$ as a factor.

fund returns. The leverage that achieves this is defined as

$$\gamma_i = \frac{\sqrt{1/(T-1)\sum_{t=1}^{T}(R_{it}-\overline{R}_i)^2}}{\sqrt{1/(T-1)\sum_{t=1}^{T}(R^*_{it}-\overline{R}^*_i)^2}}$$

and the returns on the new cloned strategy are given by:

$$\widehat{R}_{i,t} = \gamma_i R^\star_{i,t}$$

Report the average returns on the linear clones $R^\star_{i,t}$, the 'levered up' linear clones $\widehat{R}_{i,t}$, the actual returns $R_{i,t}$.

3. Compute and plot the autocorrelations up to lag 12 for the cloned returns $\widehat{R}_{i,t}$ of the DJ CS index for each of the Hedge Fund Categories (available in the DJ CS worksheet). Compare with the autocorrelations for the actual hedge fund returns.

4. Test the null that the first 12 autocorrelations of cloned returns $\widehat{R}_{i,t}$ are zero for each of these Hedge Fund Categories.

5. Based on your findings, what we have learned about the liquidity of hedge fund returns? Is there a remedy?

References

Getmanski, M., A. W. Lo, and I. Makarov (2004). An econometric model of serial correlation and illiquidity in hedge fund returns. *Journal of Financial Economics 74*(3), 529–609.

Hasanhodzic, J. and A. W. Lo (2007). Can hedge fund returns be replicated?: the linear case. *Journal of Investment Management 5*(2), 5–45.

Khandani, A. and A. W. Lo (2011). Illiquidity premia in asset returns: An empirical analysis of hedge funds, mutual funds, and us equity portfolios. *Quarterly Journal of Finance 1*(2), 205–264.

Ljung, G. M. and G. E. P. Box (1978). On a measure of a lack of fit in time series models. *Biometrika 65*(2), 297–303.