46-979: MSCF ASSET MANAGEMENT
Mini 2, 2015
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Homework 5: Hedge Funds – Performance Evaluation and Replication
Due: December 9, 2015

Hedge funds are largely unregulated, opaque, and illiquid investment vehicles that charge very high fees from their investors. Managerial skill in pursuing highly sophisticated dynamic investment strategies has often been cited as a justification for the high fees. This has prompted academics to explore whether hedge funds are genuinely generating alpha or whether their returns can be explained by exposures to common systematic risk factors, i.e. betas. In the latter scenario, it may be possible to obtain hedge-fund-like returns without investing in hedge funds by designing a low-cost passive portfolio of the risk factors (provided the risk factors can be adequately represented by passive portfolios).

This exercise explores the extent to which the variation in hedge fund returns can be explained by market-related factors. To the extent that hedge fund returns can be replicated, you are asked to construct linear clones using a small number of factors and compare their performance to the original funds.

We shall focus on the six risk factors in Hasanhodzic and Lo (2007), namely, (a) SP500: the S&P 500 total return, (b) USD: the US Dollar Index return, (c) BOND: the return on the Corporate AA Bond Index, (d) CREDIT: the spread between the BAA Corporate Bond Index and the Treasury Index, (e) CMDTY: the Goldman Sachs Commodity Index (GSCI) total return, and (f) DVIX: the first-difference of the end-of-month value of the CBOE Volatility Index (VIX). These factors are all tradable via liquid exchange-traded securities such as futures or forward contracts.

1. **Performance Evaluation:** For a chosen set of five hedge fund indexes *i* (the time series of the returns data are on Blackboard), estimate the following regression:

$$R_{i,t} = \alpha_{i1}D_1 + \alpha_{i2}D_2 + \alpha_{i3}D_3 + \alpha_{i4}D_4 + (D_1X_t)\beta_{i,D1} + (D_2X_t)\beta_{i,D2} + (D_3X_t)\beta_{i,D3} + (D_4X_t)\beta_{i,D4} + \varepsilon_{it}$$

where, $X_t = [SP500_t,\ USD_t,\ BOND_t,\ CREDIT_t,\ CMDTY_t,\ DVIX_t]$.

Note: As Fung, Hsieh, Naik, and Ramadori (2008) note, a static analysis of the risk structure of fund returns is not appropriate if the funds change their strategies over the sample period. Therefore, the regression specification above allows the betas as well as the alpha of each fund to vary over time. In particular, D_1 is a dummy variable that takes the value one during the first period (till September 1998, marking the collapse of LTCM) and zero elsewhere; D_2 is a dummy variable that takes the value one during the second period (October 1998 – March 2000, marking the peak of the technology bubble) and zero elsewhere; D_3 is a dummy variable that takes the value one during the third period (from April 2000 – November 2008, marking the Lehmann bankruptcy) and zero elsewhere; and D_4 is a dummy variable that takes the value one during the final period (December 2008 onwards) and zero elsewhere.

a. Present the estimated alphas and betas for each hedge fund index in each sub period, along with their standard errors. (Note: present the results in 5 tables, one for each fund, with the rows corresponding to the variables and the columns to the sub periods.)
b. Test the null hypothesis that the betas are the same in the four sub periods.
c. Compute the adjusted-R^2 for each regression. (Note: a high magnitude of this statistic in a regression suggests that the hedge funds in the index take on a significant amount of factor risk.)
d. Discuss the results. In particular, which categories of funds have the highest α? Which have the lowest α? How do the risk exposures, β, vary across the fund categories? How does the adjusted-R^2 vary across the categories? (Note: indexes with small factor exposures will, in general, have low adjusted-R^2.)

Having shown that a significant proportion of the variation in hedge fund returns can be explained by exposures to common market-related risk factors, we will now investigate whether it is possible to earn hedge-fund-type returns without actually investing in hedge funds.

2. **Linear Clones of Hedge Funds:** We are going to use the entire sample of a given index's returns to estimate a set of portfolio weights for the instruments corresponding to the risk factors used in the linear regression.

a. For each index i, estimate the time-series regression in (1) above but excluding the intercepts:

$$R_{i,t} = (D_1 X_t)\beta_{i,D1} + (D_2 X_t)\beta_{i,D2} + (D_3 X_t)\beta_{i,D3} + (D_4 X_t)\beta_{i,D4} + \varepsilon_{it}$$

Constrain the beta coefficients to sum to one to yield a portfolio interpretation for the weights.

b. Compute the replicating portfolio returns, R_{it}^*, as the fitted values from the above regression.

c. Renormalize the resulting portfolio returns so that it has the same volatility as the original index returns: $\hat{R}_{it} \equiv \gamma_i R_{it}^*$, where $\gamma_i = \sqrt{\frac{(R_{i,t} - \bar{R}_i)^2}{(R_{it}^* - \bar{R}_i^*)^2}}$. This makes for a fair comparison between the clone portfolio and the hedge fund index. As noted in Hasanhodzic and Lo (2007), the renormalization is equivalent to changing the leverage of the clone portfolio, i.e. the sum of the renormalized portfolio weights may exceed or be smaller than one. They, therefore, suggest introducing an additional asset that represents leverage (borrowing or lending) such that the sum of the weight on this asset, δ_i, and the renormalized weights on the six risk factors is unity: $\gamma_i \sum_{j=1}^{6} \beta_i^j + \delta_i = 1$, and the return on the clone portfolio is $\hat{R}_{it} = \gamma_i \sum_{j=1}^{6} \beta_i^j X_t^j + \delta_i R_{l,t}$. Use the one-month TBill rate as a proxy for $R_{l,t}$.

i. Compare the mean, volatility, and Sharpe ratio of the linear clones with those of the original fund indexes.

ii. Plot the cumulated returns of the indexes and their linear clones.