Problem Set 2: Building Stat Arb Portfolios

California Institute of Technology
BEM 114: Hedge Funds
Spring 2023

Due: April 21, 2023

Introduction

In this homework assignment you are asked to replicate simple stat arb strategies using historical financial data. I have uploaded a copy of the CRSP database to Canvas, called "crsp_1926_2020.csv." This database contains monthly stock returns, and also prices and shares outstanding. The Fama French, Momentum, and Industry factor returns can be obtained from Ken French's website.

Submission Instructions

I recommend you complete the assignment using Python, but you are free to answer the questions in the programming language of your choice. Please submit your assignments on Canvas before 11:59 p.m. on the due date. Assignments should be **typed**, and the first page should include the names and student IDs of all members in your group. Please upload a PDF file with your answers, and a replication package containing your code. You do not need to submit the data.

Questions

1. **Data Cleaning and Summary Statistics**: Financial data is notoriously messy, and the CRSP ("The Center for Research in Securities Prices") database aims to supply a high-quality database of security prices and data. CRSP covers all U.S. stocks but will also list ETFs and other securities that trade on exchanges. We need to be judiciously careful when cleaning our database to ensure we are looking at stocks only.

   (a) (5 points) Clean the CRSP data using the following conditions:
   - Only include stocks that are ordinary/common shares (shrcd = 10 or 11),
   - Only include stocks listed on the NYSE, AMEX, or NASDAQ (exchcd = 1, 2, 3),
   - Set negative prices to NA (prc < 0). Negative prices occur when the stock has no trading on that particular day, and negative prices represent the midpoint of the bid-ask spread.

   (b) (5 points) Plot the number of listed firms per month over the entire sample period.

   Total for Question 1: 10

2. **Replicate Size**: Gene Fama and Ken French published the size and value factors in June 1992. In this question we will replicate the size strategy up to June 1992, and then also from July 1992 to present.

   At each month t, sort stocks into ten deciles by size. Each month take a long position in the small stocks and a short position in the large stocks, and repeat the following month.

(a) (5 points) Form the equal- and value-weighted portfolios for the ten size portfolios.

(b) (5 points) Calculate the mean monthly returns for each decile, are these monotonic?

(c) (5 points) Form the long-short small-minus-big portfolio and calculate the mean, volatility, and Sharpe ratio.

(d) (5 points) Estimate the CAPM and FF3 models for both equal- and value-weighted portfolios. How do the alphas change?

(e) (5 points) Does size still work? Investigate the strategy performance after the Fama French 1992 paper was published. How about after the Dot-Com Bubble burst (starting in around 2002)?

Total for Question 2: 25

3. **Replicate Momentum**: Narasimhan Jegadeesh and Sheriden Titman first published the momentum strategy in March 1993. In this question we will replicate the momentum strategy.

   To form these portfolios, at each month t calculate cumulative returns for each stock i over the 11 month period from time $t-12$ to $t-1$. At each month, sort stocks into ten deciles by past returns. Identify the winners as the 10% of stocks that performed the best, and the losers as the 10% of stocks that performed the worst. Each month take a long position in the winners and a short position in the "losers," and repeat the following month.

   (a) (5 points) Form the equal- and value-weighted portfolios for the ten momentum portfolios.

   (b) (5 points) Calculate the mean monthly returns for each decile, are these monotonic?

   (c) (5 points) Form the long-short winners-minus-losers portfolio and calculate the mean, volatility, and Sharpe ratio.

   (d) (5 points) Estimate the CAPM, FF3, and FF5 models for both equal- and value-weighted portfolios. How do the alphas change? Does the FF5 model price momentum?

   (e) (5 points) Recall that alpha is positive either if a hedge fund manager has skill, or if the underlying model does not price all the risks that investors care about. Are the momentum alphas indicative of managerial skill? Why or why not?

   Total for Question 3: 25

4. **Replicate Betting-Against-Beta**: Andrea Frazzini and Lasse Pedersen of AQR published the Betting Against Beta strategy in January 2014. This is a strategy currently in use by AQR.[1] In this question we will replicate the Betting-Against-Beta strategy.

   The full replication is described in Franzzini and Pedersen (2014), but we will take a simpler route. The key to this strategy is to estimate rolling betas for each stock. For each stock i at month t, estimate the monthly CAPM using stock returns from $t-36$ to t and record the CAPM beta. At each month t, sort stocks into ten deciles by their estimate beta. Each month take a long position in the low beta stocks and a short position in the high beta stocks, and then repeat the following month.

[1] See: `https://www.aqr.com/Insights/Datasets/Betting-Against-Beta-Equity-Factors-Monthly`.

(a) (5 points) Form the equal- and value-weighted portfolios for the ten deciles of BAB portfolios.

(b) (5 points) Calculate the mean monthly returns for each decile, are these monotonic?

(c) (5 points) Form the long-short BAB portfolio and calculate the mean, volatility, and Sharpe ratio.

(d) (5 points) Estimate the CAPM, FF3, FF5, and FF5+Momentum models for both equal- and value-weighted portfolios.

(e) (5 points) This is an important strategy for AQR; it produces alpha, but the Sharpe ratio is quite low. Suppose you were tasked with reducing the volatility of this strategy, what might you try to do? Why?

Total for Question 4: 25

5. **Evaluating Manager Performance**: Cathie Wood is sometimes thought of as the next Warren Buffett,[2] and in this question we will compare their performance over a similar time period.

   Obtain the monthly stock returns for Berkshire Hathaway (BRK-A) and from Cathie Wood's ARK Innovation ETF (ARKK) from Yahoo Finance.

   (a) (10 points) Estimate the FF5 model for each strategy over (1) their full histories and (2) over the same sample period. Regress returns for each strategy on the Fama French 12 Industry Portfolios. Create a single table that contains all six regressions.

   (b) (5 points) Do they have similar investment strategies? Does Cathie Wood invest more like a value investor or does Warren Buffett? What industries do their portfolios behave like? Comparing this with the top 10 holdings (top10_holdings_brk_arkk.csv) does this make sense?

Total for Question 5: 15

[2] See: `https://ca.finance.yahoo.com/news/cathie-wood-next-warren-buffett-125209450.html`.