Investments Project (Spring 2024)

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Guidelines

- You have to work in groups of up to 4 students.
- You have to submit ONE project per group on Moodle. You have to register in a group on Moodle in advance.
- The project is due on **June 21 at 23:59**. Late submissions will not be accepted.
- You have to return i) a report of no more than 3 pages (excluding tables/figures) in pdf format, where you explain and justify all your results, and, ii) a separate file with your code (either a Jupyter Notebook or preferably a ".py" file). Explanations need to be concise and precise.
- Every answer has to be reported and justified in the pdf report. The report must be self-explanatory. Your grade will be based on the report.
- We must be able to run your code and reproduce all your results. The code must be written in **Python**.

1 Introduction

This project will make you build optimal portfolios combining several signals, in particular: beta, idiosyncratic volatility, and momentum. Then you will have to analyze the performance of the optimally constructed strategies, using standard risk factors obtained from Ken French's website. Lastly, you will analyze the exposure of the strategy to industry risk factors and compare two approaches to build industry-neutral optimal portfolios.

2 The Data

Download monthly stock returns from CRSP from January 1, 1964, to December 31, 2023, for all common stocks traded on the NYSE and AMEX. Also, download the value-weighted CRSP market return and 1-month T-bill returns as a risk-free rate. Many of the relevant SQL requests or Python commands are found in the previous exercises covered earlier during the semester.

3 Betting against Beta strategy (BaB)

(a) Compute the time-varying market $\beta_{t,n}$ for each stock by running monthly rolling 5-year regressions of stock-specific excess returns on the excess market return. Require at least 36 months of observations for each stock. Winsorize the beta at 5 and 95 %.

(b) At every month t, sort all stocks into deciles based on their beta (estimated using the most recent rolling window). Then compute monthly returns for 10 decile portfolios that equal weight all stocks in each decile. Plot the average annualized portfolio mean, standard deviation, and Sharpe ratios across the 10 deciles in three bar plots. Repeat for value-weighted decile portfolios. Summarize our findings. Is the evidence consistent with the CAPM?

(c) Now we construct the betting-against-beta factor as in Frazzini & Pedersen (2014). At every month t, we construct two portfolios, a high-beta portfolio w_H and a low-beta portfolio w_L, where $w_H = k(z - \bar{z})^+$ and $w_L = k(z - \bar{z})^-$ where z is a vector of cross-sectional beta ranks $z_n = rank(\beta_n)$. $\bar{z}$ is the cross-sectional average rank, and $k = \frac{2}{\mathbf{1}^\top |z - \bar{z}|}$ is a normalizing factor. $()^+$ and $()^-$ denote the positive and negative elements of a vector respectively.

(d) Construct the BAB factor return as

$$R_{t+1}^{BAB} = \frac{R_{t+1}^L - R_f}{\beta_L} - \frac{R_{t+1}^H - R_f}{\beta_H} \tag{1}$$

where $R_{t+1}^H = w_H^\top R_{t+1}$ is the return on the high-beta portfolio and $R_{t+1}^L = w_L^\top R_{t+1}$ is the return on the low-beta portfolio. $\beta_H = w_H^\top \beta_t$ and $\beta_L = w_L^\top \beta_t$ are the corresponding

betas of the portfolios. R_f is the current 1-month T-bill return. Report the mean, standard deviation, and sharpe ratio and CAPM alpha of the BAB factor.

4 Momentum Strategy (Mom)

(a) Construct the return to a long-short momentum strategy portfolio. To that effect every month sort stocks into deciles based on their 1-month lagged 11-month return (that is in month t rank stocks based on their $t-12$ to $t-1$ cumulative return).

Then compute monthly returns for 10 decile portfolios that equal weight all stocks in each decile. Plot the average annualized portfolio mean, standard deviation, and Sharpe ratios across the 10 deciles in three bar plots. Repeat for value-weighted decile portfolios. Is the evidence consistent with the CAPM?

(b) The momentum strategy is then the portfolio that goes long the three highest deciles and short the three lowest decile portfolios. Compute and compare the mean, standard deviation, and Sharpe ratios of the long and short legs of the strategy as well as of the strategy itself. Test if the strategy has an average return that is statistically significantly different from zero. Repeat both tests for equal and value-weighted portfolios.

5 Idiosyncratic Volatility Strategy (IV)

(a) Compute the time-varying estimate for each stock's idiosyncratic volatility $\sigma_{t,n}^{\text{idio}}$ obtained as the volatility of the residual in the monthly rolling 5-year regressions of stock-specific excess returns on the excess market return. Require at least 36 months of observations for each stock. Winsorize the volatility at 5 and 95 %.

(b) At every month t, sort all stocks into deciles based on their idiosyncratic volatility (estimated using the most recent rolling window). Then compute monthly returns for 10 decile portfolios that equal weight all stocks in each decile. Plot the average annualized portfolio mean, standard deviation, and Sharpe ratios across the 10 deciles in three barplots. Repeat for value-weighted decile portfolios. Summarize your findings. Is the evidence consistent with the CAPM?

(c) Now we construct the idiosyncratic volatility factor. At every month t, we go long the three highest decile volatility portfolios and we go short the three lowest decile volatility portfolios. Compute and compare the mean, standard deviation, and Sharpe ratios of the long and short legs of the strategy as well as of the strategy itself. Test if the strategy has an average return that is statistically significantly different from zero. Repeat both tests for equal and value-weighted portfolios. How do your results differ from Ang, Hodrick, Xing, and Zhang (2006; table VI page 285) and what may be the explanation for the difference?

Going forward we focus on the value-weighted portfolios.

6 Optimal Fund Portfolio Return (STRAT)

We now assume that you are running a fund that invests its assets under management in 1-month TBills and adds an 'overlay' investment in the three strategies (BaB, IV, MoM) targeting an average annual volatility of 10%. Specifically, consider the return to the fund to be $R_{fund} = R_{T-Bill} + c * R_{STRAT}$, where R_{STRAT} is the return to a strategy that combines BaB, IV, and MoM and where c is a constant that you choose so that the average annual volatility $Vol(c * R_{STRAT}) = 10\%$.

Consider three different approaches to combine the three strategies, BaB, IV, MoM to generate R_{STRAT}:

- Equal weight the strategies.
- Risk-Parity based on the rolling window estimate of the strategy returns volatilities.
- Mean-variance optimal combination based on the rolling window mean and covariance matrix of the strategy returns.

For each of the three approaches to combining the strategies compute the overall mean, standard deviation, and Sharpe ratio of the resulting 'optimal' portfolio. Going forward pick the approach with the risk-parity.

7 Performance and risk analysis for the Fund strategy

(a) Regress the time series of your strategy returns on the 12 industry portfolio returns built based on their SIC codes (as in assignment 7) as well as the Fama-French 5 research

factors (that can be downloaded from Ken French's webpage). Based on the magnitude of the beta estimates and their t-statistic, which factors seem to be significant drivers of the strategy returns **unconditionally**? Do these risk factors explain the strategy performance well (look at the R^2, the βs, and the α from the regression)?

(b) Now we want to compute the time series of the strategy exposures to the market and to the 12 industries to see if **conditional** exposure can be high at times. For each stock use its rolling estimate of its beta (computed previously) as well as its industry exposure to the 12 industries (this is simply a dummy variable equal to 1 if the stock belongs to that industry and zero otherwise) combined with the weights in your STRAT portfolio in each stock, to compute the time series of the STRAT exposure to the market and to the 12 industry portfolios. Plot the time series of the exposures to the three industries that you find are the most relevant drivers of the risk of the strategy.

(c) Compute the return to your STRAT portfolio where you hedge the exposure to all industry factors by shorting the corresponding industry portfolio, using the exposures to the different industries that you have computed before. Compute the average return, the standard deviation, and the Sharpe ratio of the 'industry-hedged' STRAT return. What do you conclude?

8 Industry neutral strategy

(a) We now consider a different approach to building a portfolio that is not exposed to industry risk. Repeat the construction of your fund strategy, but perform the strategy construction separately for each industry to build an industry-neutral portfolio. Specifically, for all the stocks in industry i (where $i \in \{1, \ldots, 12\}$) separately compute a BaB_i strategy, a IV_i, and a MoM_i strategy as proposed above. Then, repeat the fund strategy of Section 6 for each of the 12 industries, considering the risk-parity approach to combine the three strategies (BAB_i, IV_i, and MOM_i) in each industry i targeting a volatility of 10%. You obtain 12 separate strategy returns. Create a table with 12 rows where you report in the columns the mean, standard deviation, Sharpe ratio, and t-statistic associated with the mean strategy return. Which strategy delivers the most significant returns within the industry?

(b) Now combine these 12 returns using equal weights to generate a new industry-neutral

STRAT. Compute the mean, standard deviation, and Sharpe ratio associated with this new strategy. How does its performance compare to that of the previous STRAT and the previously hedged STRAT?

(c) Regress the industry-neutral STRAT onto the 17 risk factors (12 industry portfolio returns and 5 Fama-French Research Factors from Ken French's website). Discuss the alpha, betas, and R-square of that regression. How does it compare to the results you get in Section 7a?

(d) How can we explain the performance of the strategy that you just built? Is it consistent with efficient markets, with the CAPM, and with the APT?