Quantitative Portfolio Management

Assignment #4
(based on Lectures 6 and 7)

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Instructions for each assignment

- Assignments are to be done in groups of 4 or 5 students.
  - This means that groups of 1, 2, 3, 6, etc. are not allowed and will be assigned a grade of 0.
  - Diversity in groups is strongly encouraged
    (people from different countries, different genders, different finance knowledge, and different coding abilities, etc.)
- Each assignment should be emailed as a Jupyter file
  - To `Raman.Uppal@edhec.edu`
  - The subject line of the email should be: "QPM-2025-2026: Assignment n," where $n = \{1, 2, 3, 4\}$.

Instructions for each assignment

- The Jupyter file should include the following (use Markdown):
  - Section "0" with information about your submission:
    - Line 1: Submission date
    - Line 2: QPM-2025-2026: Assignment n
    - Line 3: Group members: listed alphabetically by last name, where the last name is written in CAPITAL letters
    - Line 4: Explain along which dimensions your group is diverse
    - Line 5: Any other comments about the assignment (e.g., if you think your Python code is particularly beautiful, you can mention this)
    - The same instructions apply to each assignment, so you can re-use the same Section 0 for all four assignments.
  - Section "k" where $k = \{1, 2, \ldots\}$.
    - First type Question k of Assignment n.
    - Then, below the question, provide your answer.
    - Your code should include any packages that need to be imported.

Data for this assignment

- I have provided you with an Excel file that contains the data for this assignment. You can also download the file from this: link to file with data.
- The data file for this assignment has monthly returns for nine firm-specific characteristics: Market, SMB, HML, RMW, CMA, UMD, ROE, IA, BAB.
- Assume that these returns were generated by $N = 2000$ stocks and that the number of stocks is constant over time.
- The first five characteristics (Market, SMB, HML, RMW, CMA) are from Fama and French (2015), the sixth (UMD) is from Carhart (1997), the profitability (ROE) and investment (IA) factors are from Hou, Xue, and Zhang (2015), and the betting-against-beta (BAB) factor is from Frazzini and Pedersen (2014).
- The returns for all factors are in excess of the risk-free rate.
  - In particular, every factor (besides MKT and BAB) is the return of a long-short portfolio of stocks with $1 in the long leg and $1 in the short leg, and thus, their returns equal their excess returns.
  - The MKT and BAB factors are also long-short portfolios because they are returns in excess of the risk-free rate.

Questions for Assignment 4

- Note that this assignment has two questions.
  - The first question has four parts.
  - The second question has four parts.
- Both questions are based on the same date.
- In the first question, we study the parametric portfolio policies developed by Brandt, Santa-Clara, and Valkanov (2009).
- In the second question, we study the timing portfolio policies developed in Moreira and Muir (2017), and examined further in Cederburg, O'Doherty, Wang, and Yan (2020), Barroso and Detzel (2021), and DeMiguel, Martin-Utrera, and Uppal (2024).
- The second question builds on the first one.

Questions for Assignment 4

Q1.1 Explain why one might expect these nine factors to be related to stock returns. Write only a few sentences (2 or 3 sentences) for each factor. (You can use ChatGPT, but reading the original papers would be better.)

Q1.2 Find the optimal θ vector (of dimension 9×1) for a mean-variance investor with risk aversion of $\gamma = 5$ if the investor can invest in only these nine factors. Use the entire dataset to estimate the nine factors' mean and covariance of returns (i.e., you do not need to do out-of-sample analysis).

Q1.3 Find the Sharpe ratio for each of the nine individual factors and compare it to the Sharpe ratio of the parametric portfolio you have identified in the previous question.

Q1.4 Find the optimal portfolio weights for each of the $N_t = 2000$ assets that are used to form each of the nine factors. That is, having obtained the optimal θ vector, please explain in words how one would obtain the optimal portfolio weights for each of the $N_t = 2000$ assets that are used to form each of the nine factors.

Questions for Assignment 4

Instructions for Q2.

- Use an estimation window of 120 months. Therefore, to facilitate comparison, the in-sample and out-of-sample performance should be evaluated from January 1977 to December 2020.
- In the original papers on volatility timing, volatility is computed using daily returns data. Because I have not given you daily data, please estimate current volatility using monthly data for the last 12 months.
- Define f_{t+1} to be an excess return
- Construct a new volatility-managed factor, whose return is

$$f^{\sigma}_{t+1} = \frac{c}{\sigma^2_t(f)} \times f_{t+1}, \quad \text{where}$$

  - $\sigma_t(f)$ is the previous 12 month's realized volatility, estimated using monthly data
  - choose c so f^{σ} has the same unconditional volatility as f; (if it is difficult to understand how to compute c, set $c = 1$).

Questions for Assignment 4

Q2.1 Please use mean-variance optimization to combine

- The original (without timing) factor, f_{t+1};
- The volatility-managed version of this factor, f^{σ}_{t+1}.

Q2.2 Compare the Sharpe ratios of

- the portfolio with just the original factor and
- the portfolio that includes the volatility-timed factor.

Q2.3 What do you conclude from your analysis above?

Q2.4 List the limitations of the strategy of timing factors conditional on their volatilities. Could one implement this volatility-timing policy in practice?

Bibliography

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Brandt, M. W., P. Santa-Clara, and R. Valkanov. 2009. Parametric portfolio policies: Exploiting characteristics in the cross-section of equity returns. *Review of Financial Studies* 22 (9): 3411–3447. (Cited on page 5).

Carhart, M. M. 1997. On persistence in mutual fund performance. *Journal of Finance* 52, no. 1 (March): 57–82. (Cited on page 4).

Cederburg, S., M. S. O'Doherty, F. Wang, and X. Yan. 2020. On the performance of volatility-managed portfolios. *Journal of Financial Economics* 138 (1): 95–117. (Cited on page 5).

DeMiguel, V., A. Martin-Utrera, and R. Uppal. 2024. A multifactor perspective on volatility-managed portfolios. Availble at SSRN 3982504 and forthcoming in Journal of Finance. (Cited on page 5).

Fama, E. F., and K. R. French. 2015. A five-factor asset pricing model. *Journal of Financial Economics* 116 (1): 1–22. (Cited on page 4).

Frazzini, A., and L. H. Pedersen. 2014. Betting against beta. *Journal of Financial Economics* 111 (1): 1–25. (Cited on page 4).

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Hou, K., C. Xue, and L. Zhang. 2015. Digesting anomalies: An investment approach. *Review of Financial Studies* 28 (3): 650–705. (Cited on page 4).

Moreira, A., and T. Muir. 2017. Volatility-managed portfolios. *Journal of Finance* 72 (4): 1611–1644. (Cited on page 5).

End of questions