Assignment

Asset/Risk Management II

Deadline: Nov. 17, 2025, 9:00 a.m.

Motivation

We have seen within and across various asset classes that higher risk is associated with higher average returns in the cross-section. Does this also apply to the time series, such that we can expect higher returns in periods of increased risk? *Moreira and Muir (2017)* provide evidence that this is not the case. They observe that volatility remains elevated after periods of high standard deviation, but average returns do not vary a lot with volatility. Hence, the ratio of expected returns to variance is highest for periods of low volatility, as can be seen from Figure 1.

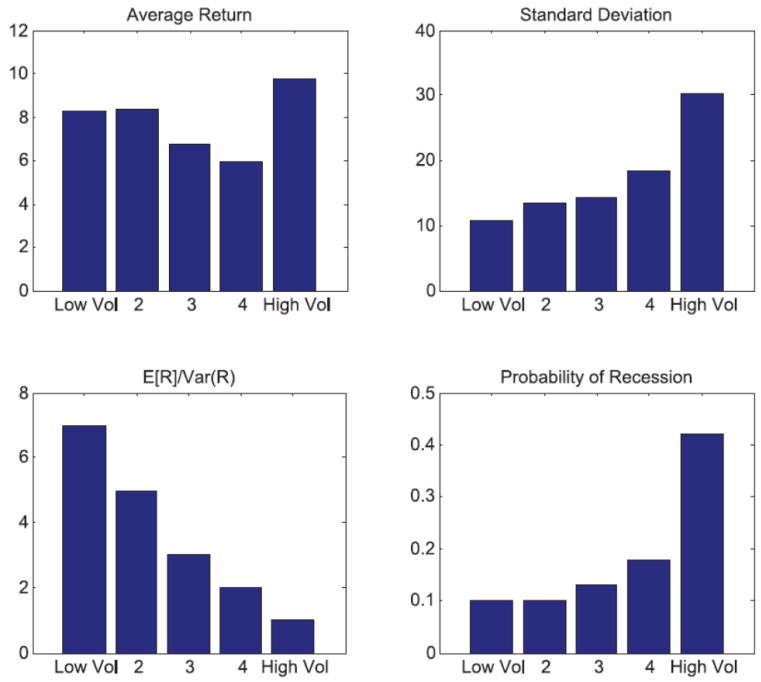

Figure 1: Source: Moreira and Muir (2017).

Part I. Replication

In this part, you will reproduce the main results from Moreira & Muir (2017) for the U.S. stock market. The goal is to make sure you understand how volatility-managed portfolios are built.

Data

Use the excess return on the U.S. stock market from 1926 to 2015. Data is available from Kenneth French's data library. Work with daily returns to estimate variance and then convert them to monthly series.

Step 1. Estimate monthly variance

For each month t, compute the realized variance using all daily returns within that month. Note that the number of trading days per month is not always the same.[1]

Step 2. Construct the volatility-managed portfolio

The managed portfolio return is defined as:

$$f^{\sigma}_{t+1} \;=\; \frac{c}{\hat{\sigma}^2_t(f)}\, f_{t+1},$$

where:

- f_{t+1} – the original monthly excess market return,
- $\hat{\sigma}^2_t(f)$ – your variance estimate from month t,
- c – a constant chosen so that the volatility of the managed portfolio matches the volatility of the original portfolio.

This means the strategy takes more risk when volatility is low and scales down risk when volatility is high.

Step 3. Sort months into variance quintiles

Sort months into 5 groups based on *lagged variance* (the variance you estimated for the previous month). Label the groups from "Low Vol" (lowest variance) to "High Vol" (highest variance).

[1] Estimate $\hat{\sigma}^2_t(f)$ over month t rather than from 22 trading days preceding month $t+1$.

Step 4. Reproduce the figures and tables

- **Figure 1:** Create four bar charts showing, for each variance quintile:
  1. Average monthly return (annualized),
  2. Standard deviation of returns (annualized),
  3. Ratio $E[R]/Var(R)$,
  4. Probability of being in a recession (use NBER recession dates).
- **Table I (Panel A, Column 1):** Run a regression of the managed portfolio on the original market return. Report:
  - Intercept
  - Slope
  - R^2, number of observations, RMSE.

Part II. Extension

In this part, you will extend the replication exercise by updating the data, changing how volatility is measured, and applying the volatility management strategy to an additional factor.

Data

Use the U.S. stock market excess return up to July 2025. In addition, use the Global Factor Returns dataset from JKP Factors. Each group should select **one** factor from the Appendix, Factor List.

Step 1. Estimate D-day variance

Compute variance using the most recent D daily returns, where

$$D = (\text{7th digit of ID}) + (\text{8th digit of ID}) + 10.$$

Example: For ID `h12345678`, the 7th digit is 7 and the 8th digit is 8, so

$$D = 7 + 8 + 10 = 25.$$

If the ID has fewer than 8 digits, treat missing digits as 0.

For month t, calculate the variance from the last D daily returns up to the end of that month:

$$\hat{\sigma}_t^2 = \frac{D}{22} \sum_{d=1}^{D} \left(f_{(t+1)-d} - \frac{\sum_{d=1}^{D} f_{(t+1)-d}}{D} \right)^2.$$

Step 2. Construct the managed portfolio and factor

Using this new variance estimate, construct volatility-managed returns:

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

where f_{t+1} is the monthly excess return (either the market or your chosen factor), $\hat{\sigma}^2_t(f)$ is the variance estimate from month t, and c is chosen so that the volatility of the managed series matches that of the original.

Step 3. Compare results

For both the original and volatility-managed versions (market and factor), report:

- Sharpe ratios (monthly and annualized),
- Maximum drawdown,
- Alpha relative to the market (CAPM regression),
- Alpha relative to the original portfolio/factor.

Step 4. Interpretation

Interpret your results. Did volatility management improve performance in terms of Sharpe ratio, drawdowns, or alpha? Briefly explain whether the managed portfolio shows clear advantages over the original.

Further Instructions

- Upload your group solution by **Nov. 17, 9:00 a.m.**
- Your upload must contain **three files**:
  - **R code:** `[StudentIDs].R` (e.g., `h12345678-h12839113.R`)
  - **Data:** everything needed to run the code, saved as `[StudentIDs].RData`
  - **Slides:** Presentation, `[StudentIDs].pdf`
- Comment your R code clearly. It must run from a clean folder where the data file is saved.
- If you use packages, your code must:
  - check whether packages are installed,
  - auto-install any missing ones from **CRAN**,
  - and then load them.

Packages not available on CRAN are **not allowed**.

- The presentation should have a title page and about five content slides. We may conduct a short oral examination if needed.

Literature

Moreira, Alan, and Tyler Muir (2017). *Volatility-Managed Portfolios. Journal of Finance* 72(4), 1611–1644.

Appendix: Factor List

1. Momentum
2. Value
3. Size
4. Profitability
5. Investment
6. Quality
7. Low risk
8. Accruals
9. Seasonality
10. Short-term reversal

Note: The Global Factor Returns can be downloaded from https://jkpfactors.com/factor-returns by selecting **All Countries**, **All Themes**, **Monthly** and **Daily** frequency, and **Capped Value Weighted**.