Volatility-Managed Portfolios

Asset and Risk Management II

17.11.2025

12427911, 12420126
Tomas Samaj, Farkas Pal Tallos

QFin

Motivation

Buy-and-Hold Strategy

- **Standard market portfolio (buy-and-hold) uses a static strategy:** It passively accepts whatever risk the market offers at any given time.
- **Market risk (volatility) is not constant:** It is predictable: high volatility in one month predicts high volatility in the next month.
- **High-volatility periods:** are precisely when buy-and-hold strategies perform the worst, often corresponding to market crashes and recessions.

Dynamic Volatility-managed Strategy

- **Moreira & Muir (2017) propose a simple, dynamic strategy that exploits the predictability:**
  - When **volatility** is **High** → **Scale Down exposure** to Market.
  - When **volatility** is **Low** → **Scale Up exposure** to Market.
- This "volatility-managed portfolio" strategy is **counter-intuitive** (it takes less risk when risk is high), yet it **generates superior performance.**

This simple, volatility scaling strategy yields remarkable results that challenge standard Asset Pricing models:

- It **doubles the Sharpe ratio** of the market portfolio.
- It generates a large, **significant positive alpha.**
- It **performs well during recessions and market crashes,** providing a hedge when it is needed most.

Managed Portfolio:

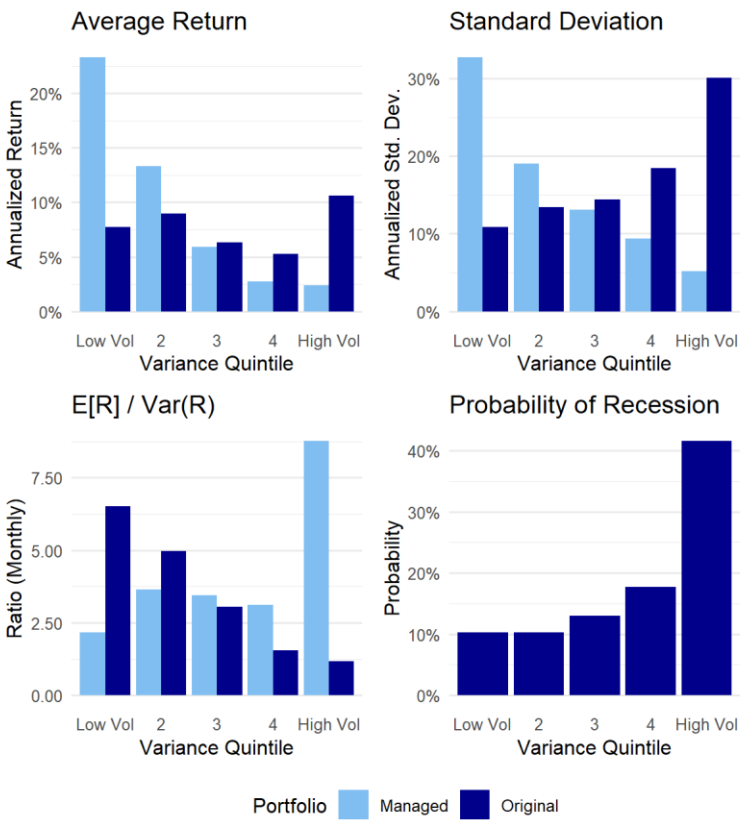
$$f^{\sigma}_{t+1} = \frac{c}{\hat{\sigma}^2_t(f)} f_{t+1}$$

f_{t+1} … buy-and-hold porfolio returns.
$\hat{\sigma}^2_t(f)$… proxy of portfolio's cond. variance.
c… constant controling the avg. exposure.

Our project goal is to reproduce the main results of Moreira & Muir (2017). By doing so, we will understand exactly how these portfolios are constructed and verify the extraordinary claim that actively managing risk can dramatically improve portfolio performance. In the second part, we extend the paper results by updating the data, changing the volatility measure and applying the strategy to an additional factor.

Replication of Moreira and Muir (2017)

Figure 1 Replication



1) We **estimate monthly variance.**

2) Construct volatility-managed portfolios.

3) Sort months into **5 variance quantiles.**

4) Replicate Figure 1 and Table 1 from the paper.

- **We manage to closely replicate the Plots in Figure 1** (Original Portfolio).
  - **Risk (SD) increases monotonically,** while **Avg. Return is U-shaped.**
  - **Probability of Recession increases with mkt. variance.**
- **Volatiliy-Managed portfolios:** both SD and Avg. Return **decrease monotonically → High returns in Low-Vol** quintiles as it takes on a lot of levered risk & **Low returns** in **High-Vol** quintiles.

Table 1 (Panel A, col. 1) Replication

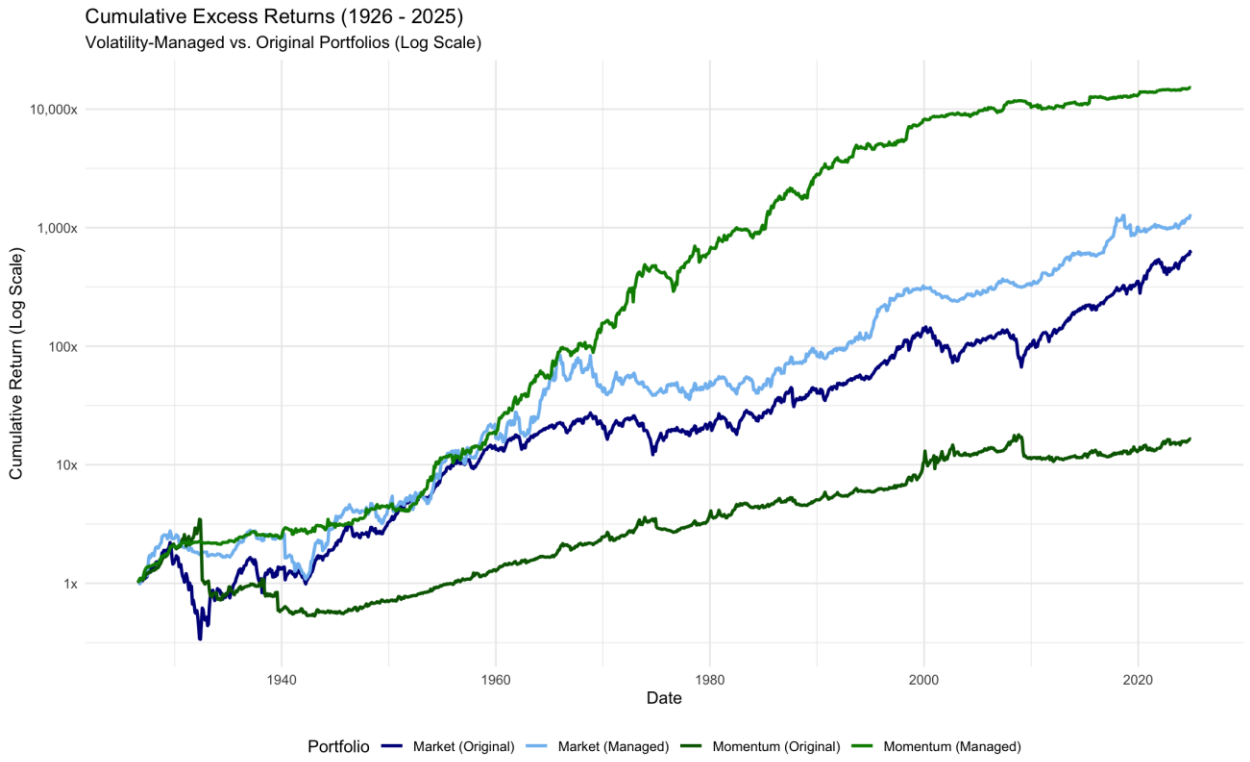
Statistic	Replicated Results	Paper Results
Alpha (a)	4.80 (1.71)	4.86 (1.56)
MktRF (Slope)	0.61 (0.09)	0.61 (0.05)
N	1073	1065
R-squared	0.37	0.37
RMSE	51.31	51.39

Note: SEs are in parentheses. Replicated SEs are Heteroskedasticity-Adjusted (HAC).

- **Regression of the managed portfolio on original Mkt. Returns** shows results **very close** to the paper.
  - **Alpha:** high and statistically significant.
  - **Market slope** (Beta): 0.61 and significant.
  - **RMSE** slightly lower than in the paper.

We manage to accurately replicate the main results of the paper. The plots in Figure 1 show that the Volatility-managed strategy works as expected, as it increases risk in Low-Vol quintiles and decreases risk in High-Vol periods. Therefore, it improves the risk-adjusted performance of the portfolio. The regression results show that a significant part of the strategy's excess returns is unexplained by the Mkt. Exc. Returns.

Extension Methodology & Data



Extension of Moreira & Muir's (2017) strategy

Objective:

- To test the robustness of the volatility-timing strategy on an **extended time series** and apply it to a new, well-known **factor:** we chose **Momentum.**

Extended Data:

- **Assets:** Fama-French US Market (Mkt-RF) and JKP US Momentum Factor
- **Time Period:** 1926-07-01 to 2025-07-31 (using daily and monthly data)

Variance Estimation:

- We calculate variance at the end of each month, using the **D=18** day rolling window (based on student ID) and the precise formula specified in the assignment

Portfolio Construction for the market and for the factor:

- The next month's return is scaled by the inverse of this lagged variance
- A constant **c** is used to scale the final strategy to match the original portfolio's volatility

The cumulative return plot provides a striking visual confirmation of the strategy's long-term value. Both managed portfolios dramatically outperform their original buy-and-hold counterparts, with the volatility-managed Momentum portfolio achieving the highest terminal wealth.

Extension: Core Performance Results

Core Performance Results (1926-2025)

Market Factor (1926-2025):

- The strategy remains robust in the extended sample, generating a statistically significant 4.02% annualized alpha (t=2.51)
- It successfully acts as a risk-management tool, cutting the Max Drawdown from -84.73% to -61.28%
- The Sharpe Ratio improves from 0.365 to 0.407, confirming the value of dynamic timing

Momentum Factor (1926-2025):

- The strategy's effect on Momentum is exceptionally strong, generating a 9.15% alpha (t=6.74) relative to the original factor
- This t-statistic is significantly stronger than the paper's (t=1.71), suggesting our D-day variance measure is a very robust signal for Momentum.
- It dramatically improves the factor's risk-adjusted-return profile, more than tripling the Sharpe Ratio (0.217 → 0.775)
- Most critically, it cuts the Max Drawdown by more than half, from a market-crash-level -84.73% to just -40.47%
- The strategy's outperformance on Momentum is driven by its ability to mitigate "crashes" - which are high-volatility events
- This strengthens the paper's core claim that the strategy works across diverse factors by dynamically hedging their specific tail risks.

Volatility-Managed Portfolio Performance
Market vs. Momentum | D = 18 days

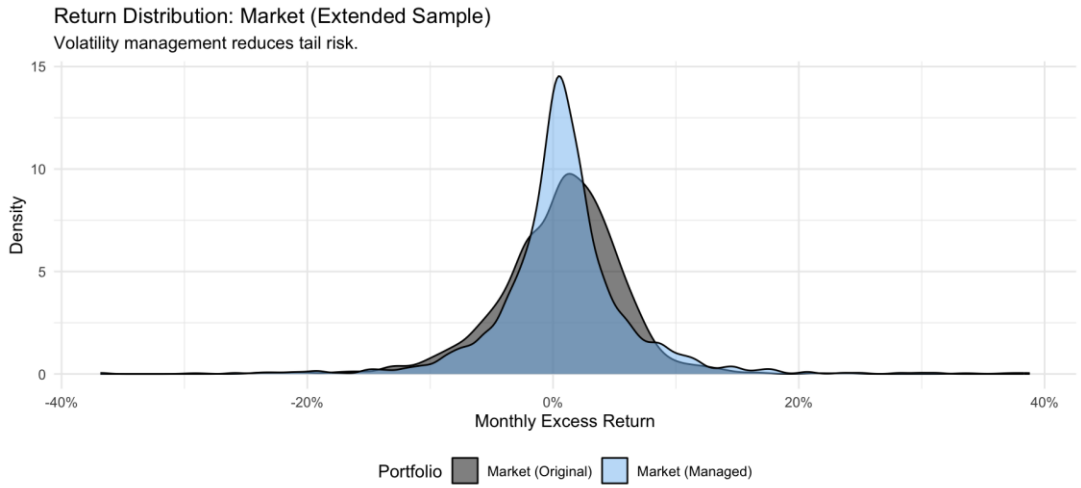
Portfolio	Annual. Sharpe	Max DD	CAPM Alpha	Alpha vs. Original
Market (Original)	0.365	84.73%	0.00% (t=0.00)	---
Market (Managed)	0.407	61.28%	4.02% (t=2.51)	4.02% (t=2.51)
Momentum (Original)	0.217	84.73%	6.28% (t=6.22)	---
Momentum (Managed)	0.775	40.47%	10.99% (t=8.16)	9.15% (t=6.74)

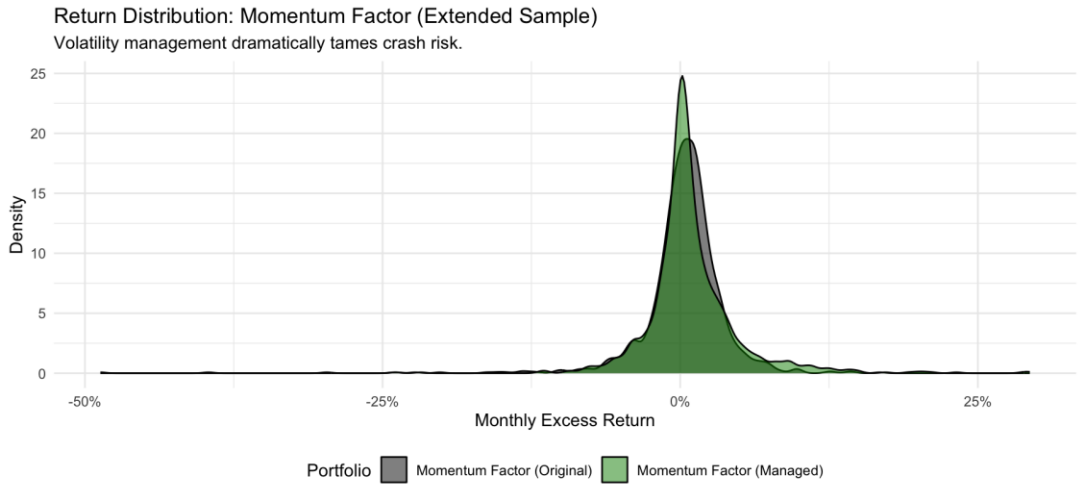
Alphas are annualized (monthly alpha * 12) and in percent. t-statistics are from HAC robust standard errors.

Alpha vs. Original: This regression $(f^{\sigma} = \alpha + \beta f^{orig} + \epsilon)$ measures the *excess return* generated by the timing strategy itself, *after* accounting for the portfolio's (now dynamic) exposure to the original factor

The results show clear statistical success. The strategy generates significant alpha (4.02% for Market, 9.15% for Momentum) and more than triples the Momentum factor's Sharpe ratio (0.217 → 0.775).

Extension: Return Distributions





Market

- The Managed portfolio's distribution (light blue) is significantly narrower and more peaked than the Original (dark grey)
- The strategy successfully "tames" the market by cutting off the extreme outcomes, especially the large negative returns in the left tail (crashes). This is the source of its lower drawdown and improved Sharpe ratio

Momentum

- The effect is even more dramatic for Momentum. The Original factor (dark grey) suffers from a severe left tail, representing the well-known "momentum crashes"
- The Managed strategy (dark green) transforms this risky distribution into a highly stable, peaked one, almost entirely eliminating the catastrophic crash risk

These plots visually confirm how the strategy works. By scaling down exposure during high-volatility periods, it systematically cuts off tail risk (crashes), leading to fewer extreme losses and a superior risk-adjusted return.

Interpretation and Conclusion

1. Did volatility management improve performance?

- **Yes,** unequivocally.
- The strategy improved performance across all three required metrics. As shown on the previous slides, it generated statistically significant, positive alpha for both the Market (4.02%) and Momentum (9.15%), all while increasing Sharpe Ratios and dramatically reducing Max Drawdowns.

2. Does the managed portfolio show clear advantages?

- **Yes, the advantages are clear and robust.** The strategy's primary benefit is its function as a dynamic risk-management tool. It generates alpha precisely because it reduces risk when it matters most.
- As shown in our density plots, it systematically "tames the tails" of the return distributions. This cut the Momentum factor's catastrophic drawdown by more than half (from -84.7% to -40.5%).
- **Economic Rationale:** Our findings support the Moreira & Muir (2017) thesis that the risk-return trade-off is not constant. Volatility is predictable, but it is not rewarded with a proportionally higher return. This strategy exploits this anomaly by taking less risk when the reward for risk is low.
- **Practicality:** The original paper confirms this strategy is not just theoretical. It survives realistic transaction costs and can be implemented even without leverage, demonstrating clear, practical advantages for an asset manager.

Our replication and extension over 99 years confirm that volatility-managed portfolios are a robust, practical, and highly effective method for both generating alpha and managing tail risk.

Bibliography & Sources

Academic papers:

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

Databases:

- https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
- https://jkpfactors.com/stock-char


Thank You!