Profitability and Peril: A Comprehensive Analysis of U.S. Equity Momentum

1. Data and Methodology

1.1 Data Description：

This study constructs a long-short strategy centered on the momentum factor using the “10 Portfolios Formed on Momentum” dataset from the U.S. market.

This dataset categorizes all U.S. stocks into 10 portfolios ranked from lowest to highest cumulative returns over the past 12 months (excluding the most recent month to avoid short-term reversal effects), dynamically updated monthly. Weighting employs a value-weighted approach to minimize interference from small-cap stocks and better reflect market realities.

1.2 Strategy Construction and Return Definition

The long-short strategy constructed in this study operates as follows: short the first portfolio of momentum-ranked stocks (selling the bottom 10% of U.S. stocks by 12-month performance) while simultaneously going long an equal number of stocks from the tenth portfolio (buying the top 10% of U.S. stocks by 12-month performance). The offsetting positions create a self-financing investment scheme aimed at generating excess returns.

The monthly return of the long-short strategy is calculated by subtracting the return of the “loser group” from the return of the “winner group,” as follows:

$$R_{LS,t} = R_{W,t} - R_{L,t}$$

Where:

$R_{LS,t}$: the net return of the momentum long-short strategy in month t;

$R_{W,t}$: the weighted average return of the 10th group (winner portfolio) in month t;

$\boldsymbol{R_{L,t}}$**:** the weighted average return of the 1st group (loser portfolio) in month t.

Calculations show that the mathematical mean of is 1.15%, indicating an expected return of 1.15% for the strategy in any given month, representing substantial monthly gains. However, these significant returns come with substantial multi-level risks.

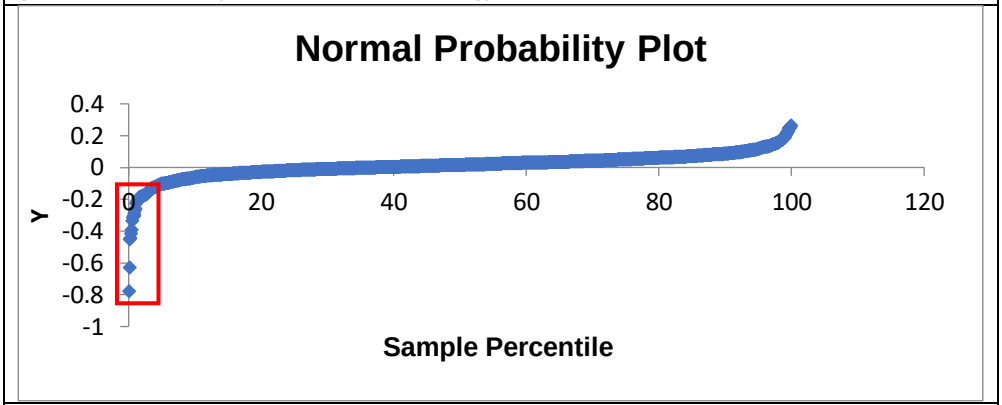
2. Risk Analysis of Momentum Strategy:

From fundamental risk metrics, this strategy exhibits a monthly standard deviation of 7.90% (compared to 5.31% for the market during the same period). However, the overall risk of the momentum strategy cannot be simply summarized by standard deviation, as the volatility reflected by standard deviation is often based on the assumption of a normal distribution, thereby obscuring the strategy's potential crash risk.

2.1 Negative Skew in Return Distribution and Tail Risk

The greatest risk of the momentum strategy lies in the extreme asymmetry of its return distribution, clearly illustrated by its normal distribution graph. The upward slope in the upper-right corner of this curve confirms the explosive profitability of momentum strategies. Yet the steep downward plunge in the lower-left corner is even more pronounced than the ascent in the upper-right, indicating a significantly negative skew in the return distribution. This exposes the strategy to substantial fat-tail effects and tail risk—meaning the probability of extreme negative returns is far higher than predicted by a normal distribution.

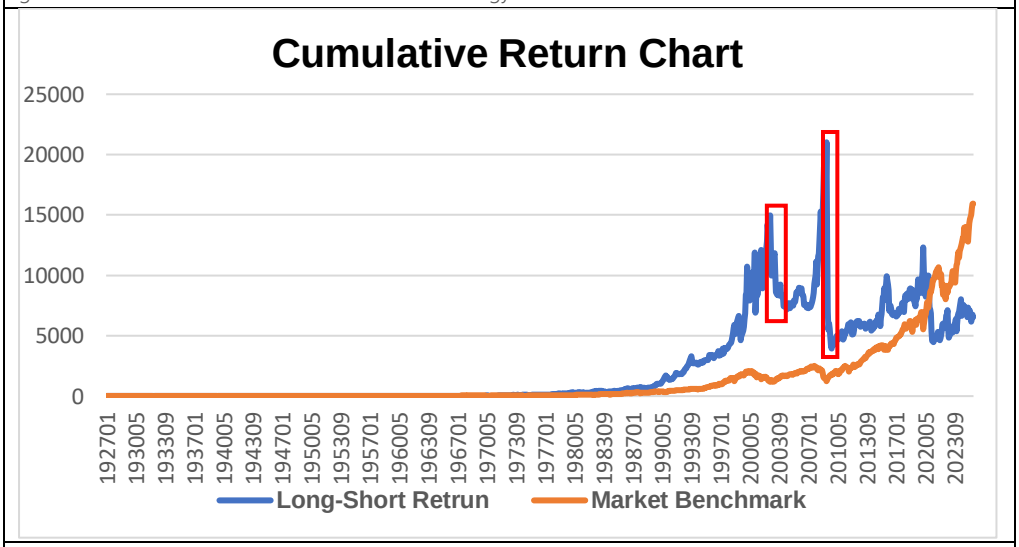
Fig.1. Normal Probability Plot of Momentum Strategy Returns



Source: Calculated from "10 Portfolios Formed on Momentum"

The multiple sharp drops in the cumulative return chart illustrate how these risks appear in reality—what are known as "Momentum Crashes." This phenomenon typically occurs during periods when markets reverse from big declines and rebound sharply (such as in 2009). As short-sold "loser stocks" in the strategy experience a short squeeze and rebound violently, the net value of the long-short portfolio suffers extreme drawdowns within an short time.

Fig.2. Cumulative Return Chart of Momentum Strategy



Source: Calculated from "10 Portfolios Formed on Momentum" & "Fama/French 3 Factors"

2.2 Deep Losses and Prolonged Recovery Periods During Extreme Drawdowns

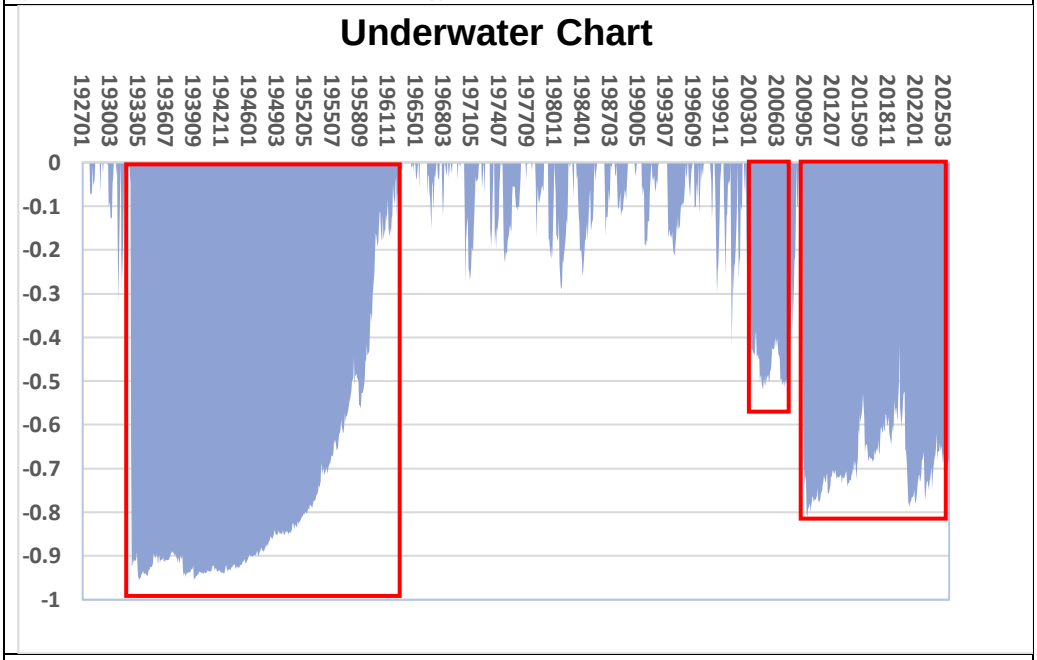
To quantify the destructive power of such collapses, we examine maximum drawdown. This metric reveals not only the extreme depth of asset depreciation but also the protracted recovery period investors face through its breadth:

In terms of depth: Data shows this strategy experienced a maximum drawdown of

95.59%. This near-total loss indicates that despite the strategy's substantial long-term gains, investors' principal faces significant threats during extreme market conditions.

In terms of duration: The drawdown chart depicts three major downturns for this strategy, corresponding to the Great Depression, the dot-com bubble, and the 2008 financial crisis on the timeline. Note the width of the blue sections within the red boxes: the longest period underwater lasted three decades. The most recent drawdown, beginning in 2008, remains unresolved to this day, with cumulative returns still in a relatively sluggish recovery phase.

Fig.3. Underwater Chart of Momentum Strategy



Source: Calculated from "10 Portfolios Formed on Momentum"

2.3 Volatility Loss and Geometric Returns in a Long-Term Perspective

Finally, we examine the specific risks posed by momentum strategies' high volatility and skewed distributions from a holistic perspective: Despite achieving high arithmetic average returns—even outperforming the market in most periods—the strategy's extreme volatility—particularly during several catastrophic "momentum crashes" (red-boxed sections in the chart)— —severely erodes the foundation of compound growth. Data indicates the strategy's geometric average return is approximately 0.82%, representing a 0.33% decline from the arithmetic mean $[G \approx$

$\boldsymbol{\mu - \sigma^2/2}]$. Ultimately, its long-term cumulative wealth even underperforms market indices. This phenomenon validates the decisive role of geometric average returns in long-term investing. While the strategy may generate substantial short-term gains due to its higher average returns, it ultimately loses to the tangible long-term erosion of geometric compounding.

3. Empirical Analysis: Validating and Measuring Alpha

To determine whether the momentum strategy's returns compensate for systematic market risk or represent genuine “excess returns” ($\boldsymbol{\alpha}$), we conducted regression analysis using the Capital Asset Pricing Model (**CAPM**):

$$\boldsymbol{R_{W,T} - R_{L,T} = R_{LS} = \alpha + \beta * \left(R_{M,T} - R_f\right) + \epsilon}$$

Where:

$\boldsymbol{R_{LS}}$: represents the excess return of the long-short momentum strategy;

$\boldsymbol{\left(R_{M,T} - R_f\right)}$: represents the market risk premium.

The regression analysis using ordinary least squares (OLS) yielded the results shown in the table below:

Statistic	Coefficient	Standard Error	t-Stat	P-value
Alpha (Intercept)	0.0150	0.0022	6.95	< 0.001
Beta (Mkt-RF)	-0.5414	0.0402	-13.47	< 0.001
R-Square	13.28%			

The intercept term ($\boldsymbol{\alpha}$) indicates that the strategy generates a monthly risk-adjusted return of 1.50%, equivalent to approximately 18% on an annualized basis, demonstrating that its returns remain substantial even after stripping out market volatility. Simultaneously, the t-statistic ($\boldsymbol{p \approx 0}$) is as high as 6.95, indicating that the result remains statistically significant at the 1% confidence level. Based on this, we

reject the null hypothesis:$\alpha = 0$, proving that the strategy indeed generates stable excess returns that cannot be explained by market risk factors.

4. Arbitrage Constraints: Specific Risk and Residual Analysis

4.1 Hedge Strategy Construction and Cash Flow Projection

After verifying the significant excess returns of the momentum strategy, we will attempt to construct an arbitrage strategy based on the CAPM model to isolate market risk and subsequently evaluate the stability of its cash flows.

We will revisit the regression results of the momentum strategy under the CAPM model, Data indicates the strategy's monthly returns correlate with market volatility at $\boldsymbol{\beta}$=-0.54 ($\boldsymbol{t}$=-13.47), suggesting momentum strategy returns often move inversely to market indices. This primarily stems from the strategy's short side experiencing substantial rebounds during active markets and steep declines during downturns, resulting in an overall negative systematic risk exposure.

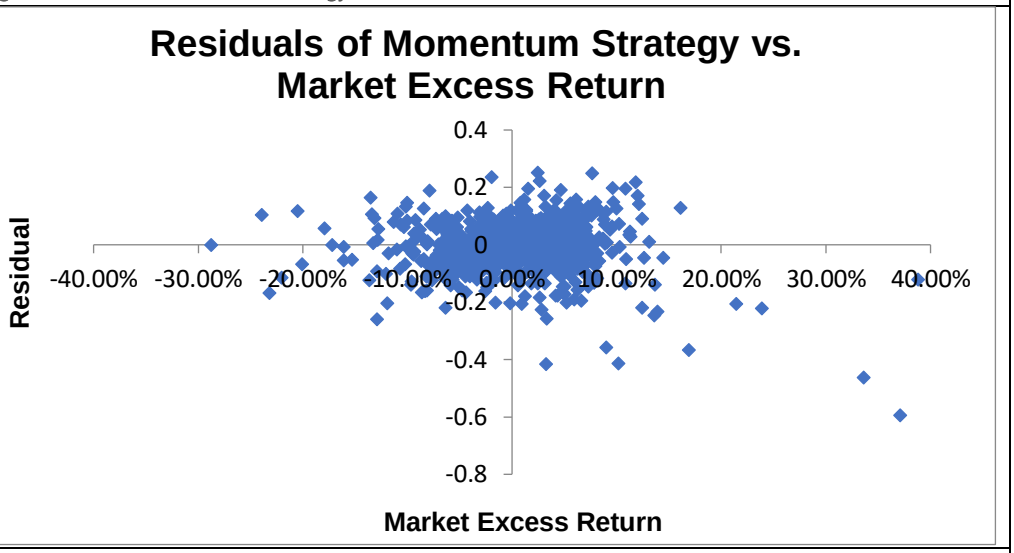
By hedging the correlation between this long-short portfolio and market volatility, we can offset market risk and capture excess returns. Assuming the long-short portfolio's short and long positions total $1,000,000, to eliminate market risk, we need to purchase $1,000,000 * 0.54 = $540,000 worth of market indices. The returns generated by this market long position will offset the volatility introduced by $\boldsymbol{\beta}$. After hedging out market risk, the strategy's expected return is the intercept term $\boldsymbol{\alpha}$. Consequently, the average monthly cash flow generated by this strategy is $1,000,000 * 1.5% = $15,000.

4.2 Idiosyncratic Risk and Arbitrage Constraints

While hedging eliminates systematic market risk, this $15,000 average monthly cash flow is not “risk-free cashflow”. Data indicates the regression model explains only 13.28% of the strategy's volatility ($\boldsymbol{R^2 = 13.28\%}$). This reveals that market factors

account for only a small portion of the strategy's fluctuations, with the remaining 86.72% representing unexplained idiosyncratic risk.

Fig.4. Residuals of Momentum Strategy vs. Market Excess Return



Source: Calculated from "10 Portfolios Formed on Momentum" & "Fama/French 3 Factors"

More intuitively, the residual distribution chart illustrates why risk-free cash flows can't be realized. The hedged residual quantifies the deviation between actual cash flows and expectations. If the model adequately explains return volatility, residuals should cluster around the zero line. However, the chart reveals that this strategy's residuals fluctuate dramatically between +25% and -60%. Combined with the extreme negative outliers in the lower-right corner of the chart, this indicates that the strategy often suffers devastating drawdowns during significant market rallies. These extreme tail risks are not eliminated simply by hedging β.

5. Real-world Limitations and Implementation Obstacles

While residual analysis demonstrates that we cannot simply obtain risk-free cash flows by hedging market risk, this is merely the beginning of the challenge. When we enter the real world shaped by transaction costs, financing constraints, and principal-agent relationships, real-world frictions will impede the conversion of alpha into actual returns and introduce additional operational difficulties for momentum strategies. The following sections explore how these real-world caveats further diminish the

strategy's investability.

5.1 High Turnover and Transaction Costs

The primary obstacle to monetizing momentum strategy profits is high transaction costs. As a high-turnover strategy, momentum requires investors to dynamically rebalance long-short portfolios monthly. This frequent trading frequency allows bid-ask spreads and commission fees to repeatedly erode investment returns, hindering the conversion of excess profits into actual gains. Furthermore, academic research (e.g., **Lesmond, Schill, & Zhou, 2004**) indicates that a significant portion of momentum strategy's excess returns often originates from illiquid small-cap stocks (particularly on the short side). Shorting these stocks incurs substantial costs, and after accounting for these real-world expenses, the significant alpha observed in Section 3 is substantially diminished.

5.2 Funding Liquidity and Margin Calls

The second challenge facing this strategy is liquidity constraints and margin calls. As a long-short strategy involving short selling and leverage, historical data shows the momentum strategy has experienced numerous periods of severe losses. In practice, this means brokers will issue margin calls. If investors cannot quickly raise sufficient funds after losses occur, their accounts will be forcibly liquidated. Consequently, real-world investors often cannot simply ride out market volatility as they might in simulations. Instead, they are forced out of the market when facing substantial losses, converting paper losses into permanent capital losses.

5.3 Agency Problems and Career Risk

Even if investors possess sufficient capital to meet margin calls, the duration of drawdown periods can trigger intractable agency issues. The drawdown chart reveals this strategy endured a 30-year “underwater period.” For fund managers required to report quarterly or annual performance, such prolonged underperformance is unacceptable. Facing extreme volatility and extended drawdowns like those in 2009 would trigger massive client redemptions, creating severe career risks. Managers

could be forced out of the market before the strategy recovers to its high water mark. Consequently, institutional investors find it practically impossible to maintain this long-term strategy.

6. Sources of Excess Returns: Theoretical Attribution

By now, we have comprehensively quantified the return characteristics of the momentum strategy, revealed the asymmetric tail risks underlying them, and demonstrated how real-world frictions impede the realization of risk-free arbitrage. Finally, we will explore the origins of the substantial and significant alpha generated by momentum strategies. Drawing on academic literature, we will attempt to explain the excess returns of momentum strategy from two dimensions: behavioral biases and risk compensation.

6.1 Behavioral Finance Perspective: Price “Convergence” Toward Value in the Context of Irrational Behavior

The first explanation posits that the momentum effect arises from market imperfections. Psychological biases among investors lead to underreaction to information, while momentum representing the process of prices correcting from “erroneous” to “correct” levels.

Barberis, Shleifer, & Vishny (1998) proposed the BSV model, demonstrating that investors' conservative bias causes delayed reactions to new information like earnings announcements; **Grinblatt & Han (2005)** further noted that under the “Disposition Effect,” investors tend to prematurely sell profitable stocks while holding onto unprofitable ones long-term. This irrational behavior suppresses price increases for ‘winners’ while artificially propping up prices for “losers,” causing stock prices to deviate from their fundamental value and creating an unclosed “Spread.”

Thus, momentum returns stem from the lag in price discovery mechanisms. Over time, as information is gradually digested, prices converge toward fundamental value.

This convergence process manifests in the market as sustained price trends, generating momentum returns.

6.2 Risk-Based View: Option-like Payoffs and Market Crash Compensation

The second explanation aligns with the “momentum collapse” phenomenon discussed in Sections 2 and 6 of this paper. This perspective posits that the excess returns from momentum strategies represent a “premium” earned by investors for bearing the implicit drawdown risk inherent in such strategies.

Daniel & Moskowitz (2016) reveal that the short side (loser portfolio) of momentum strategies typically comprises severely distressed, highly leveraged, or even near-bankrupt firms. According to **Merton's (1974)** structured model, these companies' equity essentially resembles deeply out-of-the-money call options—meaning they become worthless if the market does not rebound, but surge exponentially if it does.

The core profit of momentum strategies stems from “shorting losers,” which is equivalent to selling these implied call options. During steady market declines, selling options generates stable “premiums.” However, when markets rebound sharply from panic (as in 2009), these high-beta “losers” experience retaliatory surges, causing massive strategy losses.

From this perspective, the excess returns of momentum strategies are fundamentally a risk premium for investors who bear the risk of “suffering massive drawdowns during market recoveries.”

Conclusion: This study empirically analyzes the momentum strategy in the U.S. stock market, confirming its statistically significant long-term excess returns (α **≈1.5%**). However, in-depth risk attribution reveals that these high returns are not a free lunch but involve substantial tail risk.

The momentum strategy exhibits characteristics of “negative skew in return distribution” and “slow recovery from sharp drawdowns.” Although CAPM regression

indicates its potential to hedge market risk ($\boldsymbol{\beta} < \mathbf{0}$), residual analysis and the 2009 momentum crash case reveal that its idiosyncratic risk cannot be effectively hedged. Furthermore, practical frictions such as transaction costs, financing constraints, and agency problems make it difficult to fully capture theoretical $\boldsymbol{\alpha}$ in real-world implementation.

In summary, the excess returns of momentum strategies stem both from delayed reversion to the mean under behavioral finance perspectives and from compensation for crash risks under risk perspectives. Investors applying momentum strategies should incorporate risk management mechanisms to avoid extreme tail risks.

References

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