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The Momentum Effect in China's Stock Market

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Abstract

The momentum effect refers to a phenomenon that past winners will out performance in the future. In this paper, we examine the momentum effect of China's stock market by using a data set of China's stock market in 2009-2022. Focusing on Anchor (52-Week-High momentum), VaR (left-tail momentum) and MOM (traditional cross-sectional momentum indicator), we use single variable sorting, double variable sorting and Fama-Macbeth regression to study the performance of the momentum strategies mentioned above. We find that the left-tail momentum strategy produces a significant alpha but the other two strategies do not.

Keywords

Stock Market, Momentum Effect, Factor Model

1. Introduction

In recent years, numerous scholars have conducted research on momentum strategies in the European and American stock markets. However, there is a lack of research examining the existence of the momentum effect in China's stock markets. If there exists a significant momentum effect in China's stock market, investors can build portfolios with high past returns and sell stocks with low returns, creating a zero investment portfolio that can mitigate risks and generate excess returns.

We examine three types of momentum effects in China's stock market: traditional cross-sectional momentum, left-tail momentum, and 52-Week High momentum. Firstly, we find that the traditional cross-sectional momentum effect is not present in China's stock market. Zero-cost portfolios reveal a weak reversal effect, where the returns are primarily driven by the underperformance of stocks with high cross-sectional momentum. The alpha of loser stocks is significantly less significant than that of winner stocks. Secondly, we observe the existence of left-tail momentum effect in China's A-share market, although its potency is not overwhelming. Our findings reveal a negative correlation between left-tail risk and expected returns, suggesting the possibility that investors may have underestimated the persistence of left-tail risk. Zero-cost portfolios under left-tail momentum exhibit a significant negative alpha, primarily driven by the extreme underperformance of portfolios with high left-tail risk. Simultaneously, portfolios with low left-tail risk show an alpha close to zero, which is the same as the cross-sectional momentum effect. Finally, the 52-Week High Momentum also displays a weak reversal effect, similar to the traditional cross-sectional momentum. As the momentum of the 52-Week High increases, the alpha of the portfolio gradually decreases.

This paper contributes to the existing literature by conducting an empirical examination of the momentum effect in the Chinese stock market. While extensive research has been conducted on the momentum effect in mature stock markets like the United States, there is a relative lack of studies on its existence in the Chinese stock market. To address this gap, we examine traditional cross-sectional momentum, left tail momentum, and 52-Week High momentum in the context of the Chinese stock market and analyze whether long-short portfolios can achieve excess returns. By providing comprehensive evidence for the existence of these three momentum effects, this study enhances our understanding of the effectiveness of China's stock market and offers valuable insights for investors to make informed decisions.

The remainder of the article is organized as follows. Section 2 provides literature review. Section 3 describes the data and variables. Section 4 presents the empirical results. Section 5 concludes.

2. Literature Review

The momentum factor has been a subject of extensive research for specialists and scholars worldwide. Foreign scholars initiated the study of the momentum effect in stock markets at an early stage. For instance, Jegadeesh and Titman (1993) provided the first empirical evidence of the momentum effect by analyzing the daily return rate data of the American stock market. They subsequently proposed a three-factor model to explain stock return rates.

Afterwards, Fama and French (1996) conducted a study using data from stock markets in other countries to investigate the existence of momentum effects. Their research was followed by Carhart (1997), and Moskowitz and Grinblatt (1999), who further confirmed the presence of the momentum effect. Carhart (1997) added the momentum factor to extend the three-factor model proposed by Fama and French (1993), resulting in the Carhart four-factor model. During this period, Rouwenhorst (2000) introduced zero-cost arbitrage portfolios in twelve European national markets and 20 emerging markets, revealing a notable momentum effect. Consequently, these studies collectively offered robust support for the existence of the momentum effect in various markets.

Moreover, foreign scholars have explored other aspects related to the momentum effect, including its relationship with stock market liquidity and transaction costs. Jegadeesh and Titman (2001) further examined the momentum effect using out-of-sample data to address criticisms suggesting that their earlier study in 1993 was a product of erroneous data mining. De Groot et al. (2012) highlighted the significant presence of momentum effects in emerging markets, while Asness, Moskowitz, and Pedersen (2013) provided evidence of widespread momentum effects across multiple global markets.

Moskowitz and Grinblatt (1999) highlighted the significant presence of stock momentum not only at the individual stock level but also within industries. For instance, Jostova et al. (2013) examined the momentum effect in the corporate bond market, while Narayan et al. (2015) discussed the momentum effect in the commodity futures market. Furthermore, empirical studies by Menkhoff et al. (2012) and Orlov (2016) demonstrated the noteworthy presence of the momentum effect in foreign exchange markets.

Various opinions exist regarding the causes of the momentum effect, and scholars have provided explanations from different perspectives. Jegadeesh and Titman (1993) argued that the momentum effect arises due to investors' insufficient response to stock prices, leading to inadequate price adjustment to new information.

Additionally, proponents of behavioral finance, such as Barberis, Shleifer, and Vishny (1998), contend that investors' cognitive and behavioral biases, as well as decision-making errors, contribute to the momentum effect. Chordia and Shivakumar (2002) and Antoniou, Lam, and Paudyal (2007) have argued that the momentum effect is caused by the economic cycle. Hur and Singh (2016) further emphasize that investors' inadequate response to stock prices is the primary reason for the momentum effect. However, Griffin, Ji, and Martin (2003) and Ji, Martin, and Yao (2017) have challenged this viewpoint, contending that macro factors are not accurate in explaining the momentum effect.

In sharp contrast to the above research, domestic scholars began to study momentum effect in the 1990s, which was later than foreign scholars. China's early research mainly focused on the A-share market. A large number of studies show that the momentum effect was not obvious in the A-share markets of Japan and China.

There was a divergence of opinions among scholars in China regarding the existence of momentum effect in the stock market. Wang and Zhao (2001) were the first to explore the momentum effect in China's stock market and concluded that it was not significant. However, Zhou (2002) arrived at a different conclusion, identifying a notable one-month short-term momentum effect in China's stock market. In contrast, Lin and Tang (2005) found no evidence of medium or long-term momentum effect, but did observe a weak medium and long-term reversal effect. Wang Zhiqiang conducted a comprehensive study on stocks and concluded that momentum effect is absent in China's stock market. Expanding on this research, Liu and Pi (2007) used a longer data sample but failed to find any obvious presence of momentum effect. Similarly, Lu and Zou (2007) discovered that the momentum effect in China's stock market was not as apparent as that in foreign markets. On the other hand, Pan and Xu (2011), through grouping tests of multiple time frequencies, found that the reversal effect of stocks in the A-share market was more significant in various time periods, while the momentum effect was only evident in ultra-short time frequencies and specific weekly frequencies.

With the gradual opening and development of China's mainland stock market, domestic scholars' research on momentum effect has gradually extended to other markets, such as Hong Kong and Taiwan. At the same time, some scholars have studied the data of different time periods. For example, Sun Qi conducted an empirical study on the data of A-share market and found that the momentum effect has gradually weakened in the past few years.

There was a commonly accepted explanation for the momentum effect phenomenon observed in China's A-share market, which was explained by the multi-factor model. After that, Song et al. (2017) introduced the liquidity factor into the Fama-French five-factor model and found that it could explain a significant portion of the observed momentum characteristics. Meanwhile, Zhu et al. (2017) noted that the three-factor model could not adequately explain the excess return of stocks. In essence, research on the momentum effect should consider both the influencing factors identified in behavioral finance and the accuracy of empirical data used in factor models.

3. Data and Variables

3.1. Data

The data in this paper comes from Tushare, and the research scope is all the stocks in CSI 300.

1) The most basic data includes bm and other financial data, daily return of CSI 300, past daily return of individual stocks, daily return of one-year Treasury bond, technical index data (closing price, trading volume, total nominal trading volume, etc.), turnover rate, etc.

2) The data of independent variables are obtained from the basic data through calculations, including traditional cross-sectional momentum, anchor, VaR, es, and some control variables, which are factors that have been widely accepted, such as beta, size, etc., and aret_data (that is, afore -return data, etc.). The n-day return of individual stocks, suspend_data (stock fluctuation limit and trading suspension data), and etc.

3.2. Variable Definitions

Variable Names	Variable definition
anchor	52-Week High point for anchor

Continued

beta	Covariance of the daily excess return of stocks and the daily excess return of the market within the past year/variance of the daily excess return of the market
bm	Book value/market value of the stock at the end of month t
Cross-sectional momentum	Cumulative gains from momentum strategies
size	Stock market value
str	One-month lag stock returns
VaR	Value at risk, the first percentile of daily returns over the past year to the end of t, multiplied by −1
illiq	Illiquidity indicator. The absolute daily return of the stock/the average daily dollar volume for all trading days of the stock in t months
ES	Expected gap, daily earnings less than or equal to the average of the first percentile in the past year to the end of month t, multiplied by −1

Note: If other symbols appear, those appearing in the article prevail.

4. Empirical Results

4.1. Descriptive Statistics

Table 1 Panel (a) provides a comprehensive analysis of descriptive statistics and correlation coefficients for all variables examined in this study. The descriptive statistics include the mean, standard deviation, 25th percentile, median, 75th percentile, minimum, maximum, skewness, kurtosis, and autocorrelation coefficient, which shed light on the characteristics of the cross-sectional variables. The variables under investigation can be categorized into two groups. The first group comprises the study variables, namely 60-day momentum, 120-day momentum, 250-day momentum, anchor, VaR, and ES. The second group consists of company-specific attribute variables, such as size, beta, bm, str, and illiq. Of particular interest is the average value of VaR, which stands at 5%. This suggests that there is a mere 1% likelihood of a typical firm experiencing a daily loss exceeding 5% based on the previous year's data. Moreover, the minimum VaR value is 9%, indicating that the lowest 1% of the company's daily returns over the past year corresponds to a negative 9%. The distribution of VaR exhibits a left-skewed and mildly peaked pattern, evident from its skewness of −0.2 and kurtosis of 1.06. Accordingly, the expected loss demonstrates a mean value of 7%, with a skewness of 0.37 and kurtosis of 1.86. This distribution displays a right-skewed pattern and a higher peaked state.

The results presented in Table 1 reveal that the mean value of the anchor variable is 0.73%, accompanied by a skewness of −0.23 and a kurtosis of 0.4. These findings suggest that the 52-Week High has an average value of 0.73% and exhibits a left-skewed and finely peaked distribution. Regarding the traditional

Table 1. Descriptive statistics and correlation matrix.

(a)

	Mean	St Dev	25th Per	Median	75th Per	Min	Max	Skew	Kurt	AR	n
anchor	0.73	0.12	0.65	0.73	0.81	0.31	0.99	−0.23	0.4	0.06	2034
beta	0.99	0.23	0.86	1	1.13	0.05	1.84	−0.18	2.04	0.07	2034
bm	0.38	0.26	0.21	0.33	0.5	−1.37	1.93	0.17	15.38	0.16	2277
es	−0.07	0.01	−0.07	−0.07	−0.06	−0.10	−0.03	0.37	1.86	0.14	2034
mom20	0.02	0.13	−0.05	0	0.07	−0.35	1.71	3.62	54.42	0.08	2191
mom40	0.04	0.17	−0.06	0.01	0.1	−0.41	2.32	3.55	53.04	0.08	2162
mom60	0.05	0.21	−0.07	0.02	0.13	−0.46	2.81	3.46	47.4	0.08	2150
mom120	0.12	0.32	−0.07	0.06	0.23	−0.52	4.08	3.57	46.87	0.08	2091
mom250	0.27	0.52	−0.04	0.16	0.44	−0.61	6.79	3.93	54.3	0.08	2001
size	21.8	1.07	21.08	21.68	22.4	19.32	27.19	0.75	1.1	0.32	2272
str	0.01	0.13	−0.06	0	0.06	−0.36	1.75	3.62	55.97	0.08	2222
var	−0.05	0.01	−0.06	−0.05	−0.04	−0.09	−0.02	−0.2	1.06	0.15	2034
illiq	0.03	0.29	0	0.01	0.02	0	9.92	21.37	754.26	0.08	2276

(b)

	anchor	beta	bm	es	mom 20	mom 40	mom 60	mom 120	mom 250	size	str	var	illiq
anchor	1												
beta	−0.21	1											
bm	−0.11	0.05	1										
es	−0.36	0.49	−0.21	1									
mom20	0.26	−0.02	−0.08	0	1								
mom40	0.34	−0.03	−0.11	0	0.68	1							
mom60	0.39	−0.03	−0.14	0	0.56	0.79	1						
mom120	0.42	−0.04	−0.2	0.04	0.39	0.55	0.68	1					
mom250	0.3	−0.02	−0.28	0.13	0.25	0.35	0.43	0.62	1				
size	0.16	0.09	0.09	−0.28	0.05	0.08	0.1	0.14	0.15	1			
str	0.42	−0.04	−0.09	−0.05	−0.05	−0.05	−0.04	−0.03	−0.02	0.07	1		
var	−0.35	0.44	−0.27	0.9	0	0	0	0.05	0.16	−0.29	−0.05	1	
illiq	0	−0.14	−0.19	−0.02	0	0	0.01	0.02	0.04	−0.16	−0.03	−0.01	1

Note: mom20, mom40, mom60, mom120, mom250 are 20-day momentum, 40-day momentum, 60-day momentum, 120-day momentum, 250-day momentum.

cross-sectional momentum variables of different durations, it is observed that the mean values increase as the time interval increases. Furthermore, these variables display a distribution characterized by right-skewed spikes. Additionally, the first-order autocorrelation coefficients for all study variables are found to be close to zero. This indicates that there is a low temporal correlation among these variables.

Panel (b) of Table 1 presents the time-series averages of the cross-sectional correlations among all variables. Notably, there is a strong correlation coefficient of 0.9 between VaR and ES, indicating a robust relationship between these two variables. Consequently, VaR is selected as the focal point for the subsequent empirical analysis. Furthermore, certain company-specific attribute variables exhibit weak correlations with left-tailed risk indicators VaR, 52-Week High, and traditional cross-sectional momentum. This suggests the possibility of uncovering new causal relationships. Specifically, smaller companies with higher market beta coefficients, lower book-to-value ratios, and higher liquidity tend to have higher levels of left-tail risk. Conversely, larger companies with lower market beta coefficients and low book-to-market capitalization ratios tend to exhibit higher 52-Week High values. As for traditional cross-sectional momentum, all variables display a negative correlation with market beta coefficients and book-to-market ratios. Additionally, larger companies tend to have higher traditional cross-sectional momentum values. Interestingly, as the time interval for the traditional cross-sectional momentum variable increases, the correlation between traditional cross-sectional momentum and illiq gradually strengthens. This implies that for momentum indicators with longer time intervals, companies with weaker liquidity tend to experience higher returns over the past t months. On average, larger companies tend to have higher market beta coefficients and liquidity levels.

Table 1 presents a descriptive statistical analysis and correlation matrix for various variables over the period 2009-2022. The variables under consideration include monthly traditional cross-sectional momentum, 52-Week High momentum, left-tail risk measures, and company-specific attribute variables. Within the dataset, the anchor variable represents the highest point in the stock price of each stock within the past year. Additionally, 20-day momentum, 40-day momentum, 60-day momentum, 120-day momentum, and 250-day momentum denote the cumulative returns of the last 20, 40, 60, 120, and 250 days, respectively. VaR represents the first percentile of a stock's daily return over the past year, while ES indicates the average of the top one percent of a stock's daily return over the same period. Beta is calculated based on the daily return of each stock over the past year relative to the CSI 300 Index, representing the market beta. BM refers to the book-to-market ratio, size represents the size of the company, str indicates the stock's return over the past month, and illiq is an illiquid indicator derived from the stock's daily return and trading volume. The dataset comprises an average of 2137 stock observations per month. The coefficients in Table 1 are averaged by the time series consisting of monthly cross-sectional values.

4.2. Univariate Sorting Analysis

In this section, we apply the popular method, univariate sorting, to examine the relationship between three types of momentum and stock's future returns. In the end of each month during 2009 and 2022, targeted stocks are sorted into 10 value-weighted groups based on their momentum loading (cross-sectional momentum, 52-Week High momentum and left-tail momentum). Then we focus on the hedge portfolio that longs the stocks with the highest momentum value and shorts the stocks with the lowest momentum value.

In **Table 2**, Panel (a) to (f) gives the results of three types of momentum respectively.

Panel (a) illustrates that individual stocks with the lowest returns in the past 60 days, namely Portfolio 1, earns an excess return of −0.03%. Starting from this, the excess return presents a U-shaped relationship with the portfolio number. In other words, when the portfolio number increases from 1 to 4, the excess return roughly increases as well. But when the number continues to go up, the corresponding excess return goes down and ends up as −0.41% in Portfolio 10. The average return difference between portfolios with extreme 60-day cross-sectional momentum is −0.38% with an insignificant Newey-West t-statistic −1.11.

However, this result doesn't necessarily mean 60-day cross-sectional momentum is weak in predicting stocks' future returns. We also examine whether these portfolios' return could be explained by popular asset pricing models like Fama and French (1993) three-factor model that involves factors like market, size and value. Interestingly, the ff3-alpha and the corresponding portfolio number also exhibit a U-shape relationship: the abnormal return (ff3-alpha) of Portfolio 1 and 10 equals −0.03% and −0.29% respectively while the maximum 0.15% is realized by Portfolio 4 like excess return above. The ff3-alpha to the zero-cost portfolio equals −0.26% and is insignificant statistically. Such findings lead us to **two important conclusions**: 1) The cross-sectional reversal mode that stocks with very high 60-day cross-sectional momentum earn very low future returns is still weak with ff3 model. The low-momentum portfolios have little exposure to FF factors and therefore their abnormal returns are close to their excess return. Portfolio 9 and Portfolio 10, however, are more likely to have negative exposure to FF factors as their abnormal returns are much larger than their excess return. As a result, compared with the excess return, the alpha return of the zero-cost portfolio becomes larger and closer to 0 and even less significant. 2) The returns of the zero-cost portfolio are mainly driven by the underperformance of stocks with high cross-sectional momentum as the alpha of Portfolio 1 is much less insignificant than that of Portfolio 10.

Panels (b) and (c) show the univariate sorting results for 120-day and 250-day cross-sectional momentum and the findings like U-shaped relationship are similar with those of Panel (a). Here, low-momentum portfolios turn to have negative rather than little exposure to FF factors. Therefore, the zero-cost portfolio's abnormal returns become even larger though still insignificant.

In Panel (d), we give the result for 250-day high momentum. Unlike cross-sectional momentum, both the excess return and abnormal return exhibit a decreasing tendency as stocks' 250-day high momentum (calculated as the ratio

Table 2. Univariate sorting analysis.

(a)

Factor: factor_60-day momentum
Return: aret_01

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess_ret	−0.0003	−0.0009	0.0007	0.0017	0.0010	0.0012	0.0012	0.0008	−0.0013	−0.0041	−0.0038
t-stats	−0.1611	−0.7215	0.6918	1.9877	1.6716	1.5455	1.3893	0.7854	−1.0452	−2.1855	−1.1126
ff3-alpha	−0.0003	−0.0009	0.0002	0.0015	0.0007	0.0008	0.0008	0.0008	−0.0007	−0.0029	−0.0026
t-stats	−0.1680	−0.7172	0.2319	1.8668	1.3379	1.0675	0.9635	0.7995	−0.5893	−1.6552	−0.7789

(b)

Factor: factor_mom120
Return: aret_01

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess_ret	−0.0022	−0.0004	0	0.0021	0.0020	0.0019	0.0008	0.0005	−0.0006	−0.0040	−0.0019
t-stats	−1.3134	−0.3494	−0.0039	2.7061	2.3885	2.3239	1.0430	0.5175	−0.3942	−1.8134	−0.5650
ff3-alpha	−0.0030	−0.0014	−0.0005	0.0016	0.0015	0.0016	0.0006	0.0009	0.0008	−0.0020	0.0010
t-stats	−1.7123	−1.0835	−0.5797	2.2282	2.0883	2.1136	0.7945	1.0741	0.5672	−1.0676	0.3092

(c)

Factor: factor_mom250
Return: aret_01

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess_ret	0.0010	0.0008	0.0004	0.0016	0.0027	0.0005	0.0012	−0.0004	−0.0018	−0.0059	−0.0069
t-stats	0.5301	0.5730	0.4199	1.8223	2.8856	0.6820	1.9265	−0.4205	−1.3203	−2.5043	−1.8599
ff3-alpha	0.0008	0.0001	−0.0002	0.0011	0.0019	0.0001	0.0008	−0.0003	−0.0009	−0.0034	−0.0042
t-stats	0.4264	0.0511	−0.2082	1.3045	2.3942	0.1606	1.2759	−0.3770	−0.7346	−1.8058	−1.2694

(d)

Factor: factor_anchor
Return: aret_01

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess_ret	0.0046	0.0025	0.0013	0.0007	−0.0004	−0.0006	−0.0008	−0.0005	−0.0022	−0.0047	−0.0093
t-stats	1.6154	1.4354	1.0461	0.6170	−0.5322	−0.9910	−0.8012	−0.3493	−1.1240	−1.5309	−1.6520
ff3-alpha	0.0032	0.0014	0.0004	−0.0001	−0.0008	−0.0009	−0.0006	0.0004	−0.0010	−0.0020	−0.0052
t-stats	1.1226	0.8213	0.3847	−0.0765	−1.3301	−1.3509	−0.6730	0.3219	−0.5369	−0.7423	−0.9762

(e)

Factor: factor_var
Return: aret_01

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low

Continued

excess_ret	−0.0021	−0.0006	0.0011	0.0009	−0.0001	0.0013	0.0010	0.0012	−0.0003	−0.0022	−0.0035
t-stats	−0.9922	−0.3912	1.1446	1.3357	−0.1739	1.7342	1.2405	1.0245	−0.2364	−1.0455	−0.0081
ff3-alpha	0.0005	0.0012	0.0019	0.0013	0	0.0006	0.0001	0.0001	−0.0016	−0.0042	−0.0047
t-stats	0.3552	1.0693	2.3278	1.9072	0.0135	0.9431	0.2248	0.1264	−1.5211	−2.4531	−1.7611

(f)

Factor: factor_es
Return: aret_01

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess_ret	−0.0015	−0.0005	0.0002	0.0011	0.0009	0.0003	0.0011	0.0013	−0.0002	−0.0027	−0.0012
t-stats	−0.6428	−0.3311	0.2244	1.7537	1.2316	0.4590	1.1726	0.9846	−0.1472	−1.4220	−0.3071
ff3-alpha	0.0014	0.0015	0.0012	0.0011	0.0009	−0.001	0.0002	0	−0.0014	−0.0049	−0.0063
t-stats	0.8070	1.2891	1.4911	1.6416	1.2016	−0.1958	0.3072	0.0328	−1.1812	−3.0996	−2.3490

of a stock's newest price to its highest price in the past 250 trading days) gets higher. The zero-cost portfolio earns an averaged excess return of −0.93% and an averaged abnormal return of −0.52%, whereas the small t-statistics demonstrate that the reversal effect is very weak (like cross-sectional momentum).

Panel (e) and (f) are about left-tail momentum defined by VAR (value-at-risk) and ES (expected shortfall), respectively. An interesting finding is that, for either VAR or ES zero-cost portfolios, the excess return is very near 0 but the ff3-alpha becomes much lower and significant. This could also be explained by the negative correlation between left-tail momentum and ff3 factors: stocks with higher VAR or ES tend to expose more (or even positively) to market, size and value risk. As a result, the alpha of portfolios with higher left-tail momentum decreases in comparison with excess return while the alpha decreases in portfolios with higher left-tail momentum. Then it's not strange to observe a greatly decreased alpha in the zero-cost portfolio. **This leads us to two major conclusions:** 1) simply longing stocks with highest left-tail momentum and shorting stocks with lowest left-tail momentum does not generate much profit itself. But the ff3 abnormal return is significantly negative due to the positive correlation between left-tail momentum and ff3 factors. This means that *left-tail momentum effect does exist in Chinese A-share market though not very strong.* 2) This effect is mainly driven by the extreme underperformance of Portfolio 10 as the alpha returns of Portfolio 10 is very significantly negative while Portfolio 1's alpha is very close to 0 statistically, which is the same as cross-sectional momentum.

Table 2 presents the results of the one-month-ahead excess returns of stocks, categorized into ten equal portfolios every month from 2009 to 2022 based on the size of various momentum indicators, including 60-day momentum, 120-day momentum, 250-day momentum, anchor, VaR, and ES. Portfolio 1 represents the smallest portfolio, while Portfolio 10 represents the largest portfolio in terms of momentum indicators. Each panel of Table 2 displays the excess return and alpha for each combination, along with the corresponding metric for High-Low analysis. ff3-alpha represents the abnormal return calculated using the Fama-French three-factor model, and the t-statistic is adjusted using the Newey-West method.

Considering the short-term reversal effect, we also examine the long-term predictive power of the three types of momentum risk. We calculate the value-weighted monthly alphas for all momentum portfolios from 2 to 12 months after portfolio construction. The results are in Table 3. Panel (a) shows that in the second month after portfolio formation, the portfolio with the highest (lowest) 60-day cross-sectional momentum earns a value-weighted excess return of −0.3% and −0.15%. The average return difference equals −0.16% with a t-statistic of −0.5467, which means 60-day momentum has little power in predicting stocks' returns during the second month after portfolio formation. But the predictive power becomes stronger when it comes to the fourth, fifth and sixth month after portfolio construction, and diminishes again if we continue moving further from portfolio formation until the difference is significant during the eleventh and twelfth month.

The similar pattern also applies to 120-day momentum while 250-day momentum, surprisingly, has nearly no long-term alpha predictive power. Generally speaking, the cross-sectional momentum is quite weak in both short-term and long-term return prediction. On the other hand, 250-day high and left-tail momentum tend to have more significant correlation with long-term returns.

Table 3 presents the results of long-term returns of stocks, divided into ten equal portfolios every month from 2009 to 2022 based on the size of six variables: 60-day momentum, 120-day momentum, 250-day momentum, anchor, VaR, and ES. The time periods considered include the next 1 - 2 months, 2 - 3 months, and so on. Portfolio 1 represents the stock portfolio with the lowest momentum indicator, while Portfolio 10 represents the stock portfolio with the highest momentum indicator. Each panel of Table 3 displays the excess return and alpha for each portfolio over the next 2 - 12 months, along with the corresponding metrics for High-Low analysis. ff3-alpha is calculated based on the abnormal return derived from the Fama-French three-factor model, and the t-statistic is adjusted using the Newey-West method.

4.3. Bivariate Sorting Analysis

In single sorting analysis, we observed the weak reversal effect of cross-sectional momentum and 250-day high momentum as well as the relatively significant left-tail momentum effect. However, these results could come from other firm-specific characteristics correlated with these explored momentum effects. A way to deal with this problem is bivariate dependent sorting.

At the end of each month, the first step is to divide all stocks within the sample into 10 groups according to various firm-specific characteristics including

Table 3. Long-term reversal test. (a) 60-day momentum; (b) 120-day momentum; (c) 250-day momentum; (d) 250-day high; (e) VAR; (f) es.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low	term
ff3-alpha	−0.0015	0.0010	0	0.0010	0.0009	0.0015	0.0011	−0.0003	−0.0009	−0.0030	−0.0016	aret_12
t-stats	−0.7953	0.7977	0.0591	1.3689	1.3633	1.9570	1.1303	−0.3064	−0.7858	−2.0366	−0.5467	
ff3-alpha	−0.0030	−0.0004	0.0006	0.0003	0.0008	0.0002	0.0002	0.0007	−0.0001	0.0006	0.0036	aret_23
t-stats	−1.8549	−0.3344	0.6856	0.4191	1.1913	0.3057	0.1848	0.8255	−0.0964	0.3378	1.2114	
ff3-alpha	−0.0056	−0.0025	−0.0003	−0.0002	0.0003	0.0017	0.0012	0.0023	0.0013	0.0017	0.0074	aret_34
t-stats	−3.2841	−2.1818	−0.3078	−0.2584	0.5634	2.4067	1.5598	2.7706	1.1961	0.8855	2.1924	
ff3-alpha	−0.0039	−0.0031	−0.0002	0.0001	0.0008	0.0006	0.0013	0.0014	0.0012	0.0017	0.0055	aret_45
t-stats	−2.8115	−3.2762	−0.2165	0.1354	1.1701	1.0173	2.0821	1.8370	1.1558	0.9735	2.0395	
ff3-alpha	−0.0038	−0.0018	−0.0006	−0.0003	0.0002	0.0005	0.0017	0.0015	0.0016	0.0009	0.0047	aret_56
t-stats	−2.6281	−1.7540	−0.7183	−0.4549	0.3521	0.8624	1.9596	1.7053	1.7073	0.6492	1.9643	
ff3-alpha	−0.0027	−0.0010	−0.0005	0.0008	0.0014	0.0012	0.0004	−0.0001	0.0010	−0.0004	0.0024	aret_67
t-stats	−1.9334	−0.954	−0.6246	1.2332	2.0226	1.9059	0.5598	−0.1550	1.0565	−0.602	0.88744	
ff3-alpha	−0.0020	0.0001	0.0006	−0.0004	0.0012	0.0004	−0.0005	0	0	0.0006	0.0026	aret_78
t-stats	−1.3952	0.0857	0.5967	−0.5320	2.2516	0.6866	−0.6920	0.0131	0.0256	0.3850	0.9527	
ff3-alpha	−0.0016	−0.0004	−0.0001	0.0008	0.0006	−0.0001	0.0002	0.0002	0.0003	0	0.0016	aret_89
t-stats	−0.7613	−0.3112	−0.1534	1.2537	1.0618	−0.1277	0.3193	0.2395	0.2399	0.0225	0.4508	
ff3-alpha	−0.0019	−0.0011	−0.0013	0.0005	0.0007	0.0010	0.0016	0	0.0002	0.0003	0.0022	aret_910
t-stats	−1.3302	−1.1198	−1.9475	0.6755	1.2532	1.5520	2.2555	−0.0564	0.2056	0.2503	0.9095	
ff3-alpha	−0.0007	0.0012	0.0013	0.0011	0.0012	0.0017	−0.0001	−0.0004	−0.0015	−0.0038	−0.0031	aret_1011
t-stats	−0.7403	1.4463	1.7309	1.6639	1.8688	2.7958	−0.0922	−0.5302	−1.9408	−3.6951	−1.8122	
ff3-alpha	0.0021	0.0025	0.0020	0.0003	0.0006	0.0003	0.0003	−0.001	−0.0026	−0.0046	−0.0066	aret_1112
t-stats	1.5291	3.0078	3.0027	0.3961	1.3997	0.5860	0.5196	−1.3673	−3.1842	−3.3682	−2.6032	

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low	term
ff3-alpha	−0.0031	−0.0008	−0.0009	0.0001	0.0017	0.0023	0.0023	0.0004	−0.0003	−0.0017	0.0014	aret_12
t-stats	−2.5336	−0.8004	−1.1411	0.1992	2.642	3.4857	3.4694	0.5206	−0.2194	−1.0196	0.5889	
ff3-alpha	−0.0054	−0.0014	−0.0017	0.0014	0.0012	0.0018	0.0008	0.0009	0.0007	0.0018	0.0072	aret_23
t-stats	−3.9625	−1.5232	−1.9975	1.8642	1.8607	3.0707	1.2401	1.0585	0.6197	0.9951	2.6801	
ff3-alpha	−0.0055	−0.0022	−0.0009	−0.0003	0.001	0.0014	0.0019	0.0026	0.0008	0.0011	0.0067	aret_34
t-stats	−3.5817	−2.2372	−1.0109	−0.3887	1.3584	2.348	3.1915	3.0388	0.6345	0.6571	2.3337	
ff3-alpha	−0.0019	−0.0006	0.0002	−0.0002	0.0001	−0.0005	0.001	0.001	−0.0001	0.0009	0.0029	aret_45
t-stats	−1.4089	−0.4563	0.2905	−0.226	0.1377	−0.8658	1.4867	1.2044	−0.0709	0.5327	1.0253	

Continued

ff3-alpha	−0.0022	−0.0007	0.0003	0.0002	−0.0002	0.0005	−0.0002	0.0003	0.0006	0.0013	0.0035	aret_56
t-stats	−1.4106	−0.5161	0.2787	0.2227	−0.2826	0.9603	−0.2917	0.3601	0.6162	0.6828	1.1412	
ff3-alpha	−0.0034	−0.0007	0.0003	0.001	0.0007	0.001	0.0006	−0.0002	0.0003	0.0005	0.0039	aret_67
t-stats	−2.9499	−0.6035	0.3109	1.2182	0.9234	1.6281	0.9236	−0.2438	0.3186	0.3022	1.6876	
ff3-alpha	−0.0005	0.0009	0.0013	0.0001	−0.0004	0.0006	−0.0005	0.0004	−0.0009	−0.0011	−0.0006	aret_78
t-stats	−0.3803	1.0012	1.4912	0.2358	−0.5933	0.9164	−0.6553	0.4188	−0.9995	−0.867	−0.2766	
ff3-alpha	0.0004	0.0021	0.0017	0.001	−0.0005	0.0006	−0.0004	−0.0005	−0.0019	−0.0025	−0.0028	aret_89
t-stats	0.2889	2.3732	1.4992	1.6278	−0.7674	0.8751	−0.6023	−0.7945	−2.1972	−1.8123	−1.1956	
ff3-alpha	0.0003	0.0013	0.0011	0.0008	0.0006	−0.0007	0.0003	−0.0008	−0.0008	−0.0021	−0.0024	aret_910
t-stats	0.2496	1.5003	1.0989	1.2115	0.8857	−0.9489	0.3613	−0.9483	−0.6925	−1.6363	−1.1057	
ff3-alpha	0.0008	0.0026	0.0015	0.0012	0.0016	0.0002	−0.0004	−0.0004	−0.0032	−0.0037	−0.0044	aret_1011
t-stats	0.6299	2.5112	1.6315	1.7665	2.9328	0.3625	−0.6848	−0.5593	−3.8729	−2.6427	−1.8577	
ff3-alpha	0.0017	0.0015	0.0017	−0.0003	0.0017	−0.0003	−0.0002	−0.0007	−0.0019	−0.0033	−0.0051	aret_1112
t-stats	1.3654	1.5911	2.45	−0.4035	2.7191	−0.3984	−0.3514	−0.725	−1.9939	−2.6897	−2.2698	

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low	term
ff3-alpha	−0.0016	0.0006	0.0013	0.0002	0.0012	0.0012	0.0009	−0.0004	−0.0016	−0.0017	−0.0001	aret_12
t-stats	−1.1736	0.5686	1.4717	0.2909	1.6301	1.899	1.4857	−0.4474	−1.4898	−1.193	−0.0595	
ff3-alpha	−0.0026	−0.0004	0.001	0.0014	0.0006	0.0005	0.0004	−0.0009	−0.0007	0.0008	0.0034	aret_23
t-stats	−1.9614	−0.4916	1.2242	1.709	0.9403	1.1999	0.5487	−1.1918	−0.6498	0.518	1.3447	
ff3-alpha	−0.0021	−0.0007	0.0005	0.0014	0.0008	0.0006	0.0006	−0.0001	−0.0002	−0.0009	0.0012	aret_34
t-stats	−1.4272	−0.7162	0.604	2.1908	1.4381	1.1241	0.9443	−0.1201	−0.1814	−0.5624	0.4421	
ff3-alpha	−0.0009	0.0013	0.0009	0.0002	0.0016	0.0001	−0.0002	−0.0021	−0.0001	−0.001	−0.0001	aret_45
t-stats	−0.6947	1.3251	1.1056	0.2882	2.463	0.2264	−0.3102	−2.5085	−0.0599	−0.6495	−0.0463	
ff3-alpha	−0.0008	0.0016	0.0016	0.0019	0.0004	−0.0003	−0.0009	−0.0024	−0.0002	−0.0009	−0.0001	aret_56
t-stats	−0.6341	1.3573	1.9621	2.2368	0.6802	−0.5579	−1.0978	−2.5709	−0.1797	−0.6315	−0.0575	
ff3-alpha	−0.0003	0.0008	0.0013	0.0016	0.0008	−0.0001	0.0002	−0.0004	−0.0018	−0.0021	−0.0018	aret_67
t-stats	−0.2033	0.8066	1.6426	2.5363	1.765	−0.1147	0.2845	−0.4812	−1.8746	−1.4257	−0.7652	
ff3-alpha	0.0008	0.0018	0.0014	0.0011	0.0007	−0.0001	−0.0001	−0.0024	−0.0015	−0.0016	−0.0023	aret_78
t-stats	0.601	1.6733	1.9817	1.5791	0.9438	−0.1714	−0.1215	−3.3109	−1.8516	−1.2855	−1.0339	
ff3-alpha	0.0004	0.0025	0.0015	0.0005	0.0008	−0.0004	−0.0005	−0.0015	−0.0015	−0.0017	−0.0022	aret_89
t-stats	0.3274	2.6485	2.1558	0.866	1.4446	−0.502	−0.9752	−1.9948	−1.6643	−1.3757	−0.9402	
ff3-alpha	0	0.0014	0.001	0.0009	0.001	−0.0004	0	−0.0013	−0.0012	−0.0015	−0.0015	aret_910
t-stats	0.0296	1.5006	1.3324	1.4028	1.7404	−0.5794	−0.0267	−1.4956	−1.2719	−1.2455	−0.6833	

Continued

ff3-alpha	0.0008	0.0008	0.0021	0.0017	0.0003	0.0013	−0.0006	−0.0015	−0.0024	−0.0024	−0.0032	aret_1011
t-stats	0.5708	0.7645	2.5082	2.3657	0.4204	1.703	−0.8229	−1.8511	−3.0048	−1.9699	−1.3859	
ff3-alpha	0.0002	0.001	0.0011	0.0011	0.0011	−0.0002	−0.0007	−0.0005	−0.0011	−0.0021	−0.0023	aret_1112
t-stats	0.1499	0.8375	1.7407	1.6443	1.8178	−0.2454	−1.0556	−0.5502	−1.2188	−1.8107	−0.9724	

(d)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low	term
ff3-alpha	−0.0024	−0.0011	−0.0011	−0.0001	−0.0004	0.0003	0.0012	0.0012	0.0023	0.0001	0.0024	aret_12
t-stats	−1.2817	−0.9521	−1.347	−0.1318	−0.5268	0.4797	1.3355	1.4347	1.7577	0.0466	0.7283	
ff3-alpha	−0.0043	−0.0027	−0.0017	0	−0.0007	0.0002	0.0015	0.0024	0.0021	0.0033	0.0075	aret_23
t-stats	−2.478	−2.471	−2.5621	−0.0024	−1.1585	0.258	1.9812	2.7609	1.9324	1.9688	2.5081	
ff3-alpha	−0.0066	−0.004	−0.0013	−0.0006	0.0004	0.001	0.0019	0.0024	0.003	0.0039	0.0105	aret_34
t-stats	−3.637	−3.5383	−1.54	−0.8514	0.7324	1.7471	2.4018	2.6391	2.2725	2.4081	3.3162	
ff3-alpha	−0.0037	−0.0012	−0.0004	0	0.0003	0.0012	0.0003	0.0005	0.0011	0.002	0.0057	aret_45
t-stats	−2.3379	−0.9133	−0.5236	−0.0363	0.3467	1.7971	0.513	0.5691	0.878	1.0124	1.8191	
ff3-alpha	−0.0033	−0.002	0.0006	−0.0002	−0.0001	0.0004	0	0.0002	0.0001	0.0043	0.0076	aret_56
t-stats	−2.1823	−2.2155	0.6307	−0.2683	−0.1179	0.608	−0.0208	0.232	0.0692	2.3584	2.5542	
ff3-alpha	−0.0033	−0.0005	−0.0016	−0.001	0.0004	0.0004	0.001	−0.0001	0.0009	0.0037	0.0071	aret_67
t-stats	−2.4506	−0.505	−1.7561	−1.6366	0.6339	0.719	1.6058	−0.0763	0.7158	2.4337	2.6558	
ff3-alpha	−0.0032	−0.0014	−0.0017	−0.0001	0.0001	0.001	0.0009	0.0008	0.0007	0.0027	0.0059	aret_78
t-stats	−2.4561	−1.5839	−2.6056	−0.0909	0.2522	1.644	1.63	1.1604	0.8587	1.7253	2.4194	
ff3-alpha	−0.0018	−0.0001	0.0006	−0.0002	0.0001	0.0003	0.0003	−0.001	0	0.0018	0.0035	aret_89
t-stats	−1.3344	−0.1299	0.8749	−0.2863	0.2159	0.3995	0.4308	−1.2668	−0.0141	1.1848	1.4027	
ff3-alpha	−0.0007	0.0003	0.0014	0.0003	0.0009	−0.0003	−0.0008	−0.0002	−0.0016	0.0006	0.0012	aret_910
t-stats	−0.5551	0.3479	1.5005	0.5164	1.3632	−0.5536	−1.0285	−0.2311	−1.7302	0.4758	0.6131	
ff3-alpha	−0.0018	0.0012	0.0003	0.0001	−0.0005	−0.0023	0.0011	−0.0006	0.0009	0.0016	0.0033	aret_1011
t-stats	−1.4687	1.1115	0.3315	0.1827	−0.914	−3.8141	1.8215	−0.7098	1.0449	1.2634	1.4933	
ff3-alpha	−0.0017	−0.001	0.002	0.0008	0.0001	−0.001	0.0004	−0.0012	0.0004	0.0012	0.0029	aret_1112
t-stats	−1.3704	−1.0424	2.2812	1.2653	0.1842	−1.6435	0.6541	−1.5088	0.3497	0.9398	1.2843	

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low	term
ff3-alpha	0.0017	0.0027	0.0021	0.0013	0.001	−0.0007	−0.0009	0.0003	−0.0026	−0.005	−0.0067	aret_12
t-stats	1.1353	2.5983	3.0509	1.5326	1.4019	−0.9702	−1.3261	0.3469	−2.6651	−3.3958	−2.7512	
ff3-alpha	0.002	0.0017	0.0016	0.0009	0.0013	−0.0005	−0.0011	−0.0007	−0.0015	−0.0036	−0.0057	aret_23
t-stats	1.4848	1.7112	1.8755	1.2937	2.2485	−0.8592	−1.4651	−0.8017	−1.5112	−2.283	−2.2386	

Continued

ff3-alpha	0.0032	0.0022	0.002	0.0002	0.0003	−0.0007	−0.0012	−0.001	−0.0016	−0.0035	−0.0066	aret_34
t-stats	2.4157	2.3374	2.6907	0.2417	0.4743	−1.0493	−1.5826	−1.2383	−1.8137	−2.3172	−2.8754	
ff3-alpha	0.0017	0.001	0.0016	0.001	−0.0014	0.001	−0.0006	−0.0005	−0.0013	−0.0025	−0.0042	aret_45
t-stats	1.1803	1.0564	2.1533	1.3879	−2.1255	1.6923	−0.8188	−0.6244	−1.2756	−1.4965	−1.666	
ff3-alpha	0.0017	0.0016	0.0016	0.0001	0.0008	−0.0004	−0.0004	−0.0011	−0.002	−0.0018	−0.0035	aret_56
t-stats	1.1149	1.7153	2.2293	0.0953	1.1621	−0.604	−0.4857	−1.204	−2.0183	−1.1084	−1.329	
ff3-alpha	0.0026	0.002	0.0013	0.0006	0	0.0008	−0.0008	−0.0004	−0.0036	−0.0025	−0.005	aret_67
t-stats	2.0182	2.5036	1.5202	0.7264	0.0278	1.3865	−1.014	−0.4451	−3.9856	−1.547	−2.3089	
ff3-alpha	0.0025	0.0012	0.001	0.0009	0.0005	0.0004	−0.0009	−0.0014	−0.0012	−0.0031	−0.0056	aret_78
t-stats	1.8589	1.5338	1.3462	1.0534	0.6218	0.6597	−1.5381	−1.9352	−1.0839	−2.0774	−2.51	
ff3-alpha	0.002	0.0012	0.0001	0.0014	−0.0002	−0.0002	−0.0006	−0.0007	−0.0011	−0.0018	−0.0038	aret_89
t-stats	1.2781	1.2721	0.1637	1.7147	−0.2573	−0.302	−0.9229	−0.9646	−1.1813	−1.3249	−1.6062	
ff3-alpha	0.0005	0.0009	0.0008	0.0007	0.0007	0.0003	0	−0.0012	0.0001	−0.0029	−0.0033	aret_910
t-stats	0.3654	1.0774	0.9478	1.0647	1.2246	0.5145	−0.0069	−1.8325	0.1577	−1.9631	−1.5082	
ff3-alpha	0.0028	0.0006	0.0009	0.002	0.0001	−0.0004	−0.001	−0.0008	−0.0019	−0.0024	−0.0052	aret_1011
t-stats	2.2773	0.6252	1.2216	2.5821	0.1274	−0.5042	−1.7892	−1.1611	−2.0126	−1.7023	−2.4462	
ff3-alpha	0.0013	−0.0001	0.0011	0.0001	0.0002	0.0014	−0.0007	−0.0006	−0.0011	−0.0015	−0.0027	aret_1112
t-stats	0.9001	−0.1223	1.6429	0.0814	0.2554	2.0104	−0.9605	−0.7203	−1.2783	−1.0077	−1.185	

(f)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low	term
ff3-alpha	0.0027	0.0026	0.0033	0.0006	0.0014	0.0001	−0.0007	−0.001	−0.0027	−0.0062	−0.0089	aret_12
t-stats	1.6276	2.5539	4.33	0.9158	2.0286	0.1271	−1.0737	−1.1724	−2.6029	−4.6161	−3.6704	
ff3-alpha	0.0026	0.0025	0.0022	0.0012	−0.0001	−0.0004	−0.0003	−0.0013	−0.0021	−0.0042	−0.0068	aret_23
t-stats	1.6562	2.9038	2.7124	1.9022	−0.1711	−0.5667	−0.4983	−1.8492	−2.0112	−2.6961	−2.5333	
ff3-alpha	0.0037	0.0019	0.0027	0.0005	−0.0001	−0.0003	−0.0009	−0.0011	−0.0024	−0.0039	−0.0076	aret_34
t-stats	2.3902	2.237	3.8131	0.6565	−0.2686	−0.4281	−1.4387	−1.3512	−2.8475	−2.7374	−3.0354	
ff3-alpha	0.0018	0.0016	0.0022	0.0001	−0.0004	−0.0007	0.0002	−0.0003	−0.0019	−0.0026	−0.0045	aret_45
t-stats	1.2343	2.0016	2.4749	0.0679	−0.7006	−1.3168	0.2611	−0.3271	−1.731	−1.6323	−1.682	
ff3-alpha	0.002	0.0018	0.0012	0.0009	−0.0005	−0.0007	−0.001	−0.0005	−0.0016	−0.0016	−0.0036	aret_56
t-stats	1.2882	1.6654	1.6854	1.315	−0.7639	−0.8368	−1.3299	−0.5164	−1.6189	−1.0499	−1.3821	
ff3-alpha	0.0036	0.0015	0.0009	0.0006	−0.0001	0.0002	−0.0007	−0.0014	−0.0028	−0.0017	−0.0053	aret_67
t-stats	2.6315	1.7263	0.9732	0.8394	−0.1132	0.2406	−1.037	−1.7948	−2.9249	−1.117	−2.235	
ff3-alpha	0.0034	0.0009	0.0012	0.0009	0	−0.0005	−0.0006	−0.0013	−0.0023	−0.0016	−0.0051	aret_78
t-stats	2.3124	0.9079	1.7898	1.6238	−0.0489	−0.9551	−0.7581	−1.8499	−2.3364	−1.0835	−2.0274	

Continued

ff3-alpha	0.0024	0.0005	0.0012	0.0013	−0.0007	−0.0017	0.0001	−0.0009	−0.0014	−0.0007	−0.0031	aret_89
t-stats	1.6034	0.5485	1.4923	1.544	−1.1388	−2.6044	0.1453	−0.9971	−1.42	−0.4934	−1.2461	
ff3-alpha	0.0021	−0.0003	0.0011	0.0008	−0.0004	−0.0002	−0.0012	−0.0003	−0.0009	−0.0007	−0.0028	aret_910
t-stats	1.65	−0.319	1.5006	0.9951	−0.4815	−0.3385	−1.7674	−0.4295	−0.825	−0.4258	−1.1618	
ff3-alpha	0.0038	0.0008	0.0019	0.0014	−0.001	−0.0013	−0.0008	−0.002	−0.001	−0.0018	−0.0055	aret_1011
t-stats	2.9184	0.7767	2.2592	2.0003	−1.5437	−2.1142	−1.0705	−2.4507	−1.0428	−1.1272	−2.2524	
ff3-alpha	0.0022	0.0002	0.0006	0.0004	0.0003	−0.0004	−0.0002	−0.0012	−0.0009	−0.0008	−0.003	aret_1112
t-stats	1.401	0.1756	0.6387	0.4876	0.4514	−0.6448	−0.1953	−1.6164	−1.0322	−0.5329	−1.2019	

Beta, Size, Book-to-market ratio, STR and Illiquid. Then in each first-stage group, we sort stocks into 10 groups based on their momentum value. As a result, we obtain 10 × 10 portfolios in each two-step dependent bivariate sorting, and we define Portfolio1 as the combined portfolio of stocks with the lowest momentum value in each portfolio sorted by firm-specific characteristics. Similarly, Portfolio10 is the combined portfolio of stocks with the highest momentum value in each portfolio sorted by firm-specific characteristics.

Table 4 presents the univariate sorting result for 60-day cross-sectional momentum. For all first-step firm specific attributes, the ff3-alpha returns are very insignificant, which means that even after controlling these characteristics, the relation between 60-day cross-sectional momentum and one-month-ahead return is very weak. The results for other cross-sectional momentum and 250-day high momentum are in Tables 5-7 and very similar with that of 60-day cross-sectional momentum.

However, in Table 8, Panel (a) shows that after controlling Size, the zero-cost portfolio could earn an averaged ff3-alpha of −0.55% with a t-statistics of −2.36. Moreover, Panel (d) reveals that after controlling STR, the averaged ff3-alpha of the zero-cost portfolio of VAR is equal to −0.55% with a t-statistics of −2.34. Table 9 presents the similar results for ES. Such findings strengthens the conclusion in 3.2 that *the negative relation between left-tail momentum and future returns does exist in Chinese A-share market though not very strong.* Again we can see that the left-tail momentum effect mainly arises from the extreme underperformance of Portfolio 10 as, in both Panel (a) and (d), the alpha returns of Portfolio 10 is very significantly negative while Portfolio 1's alpha is very close to 0 statistically.

Table 4 presents results from the value-weighted bivariate portfolios based on dependent double sorts of various firm-specific attributes and 60-day momentum between 2009 and 2022. Firstly, decile portfolios are formed every month based on a firm-specific attribute. Next, additional decile portfolios are formed based on 60-day momentum within each firm-specific attribute decile. Portfolio 1 is the combined portfolio of stocks with the lowest momentum in each firm-specific attribute decile. Portfolio 10 is the combined portfolio of

Table 4. 60-day momentum. (a) size; (b) bm; (c) beta; (d) str; (e) illiq.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0001	−0.0007	−0.0004	0.001	0.001	0.0011	0.0006	−0.0002	0.0005	−0.0028	−0.0029
t-stats	0.0663	−0.6113	−0.4248	1.2645	1.7732	1.8389	0.7111	−0.1942	0.359	−1.5398	−0.9123
ff3-alpha	−0.0002	−0.0008	−0.0008	0.0008	0.0008	0.001	0.0007	−0.0004	0.0009	−0.002	−0.0019
t-stats	−0.1063	−0.6954	−0.8685	1.0339	1.5594	1.8287	0.9351	−0.3452	0.7577	−1.1858	−0.5963

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0003	−0.001	0.0006	0	0.0013	0.0018	0.0005	0.0002	−0.0002	−0.0028	−0.0026
t-stats	−0.1524	−0.7595	0.6879	−0.0286	1.9431	2.2784	0.6276	0.1726	−0.1479	−1.7618	−0.8481
ff3-alpha	−0.0004	−0.0011	0.0004	−0.0002	0.0011	0.0015	0.0007	0.0001	0	−0.0021	−0.0017
t-stats	−0.2107	−0.8744	0.5072	−0.3955	1.7815	1.936	0.8283	0.0867	0.0428	−1.3779	−0.5833

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0003	0	0.0007	0.0018	0.0012	0.0006	0.0007	−0.0015	−0.0003	−0.0029	−0.0027
t-stats	−0.164	0.0301	0.7455	2.3702	2.27	0.8676	0.7921	−1.8	−0.2612	−1.509	−0.7944
ff3 alpha	−0.0005	−0.0001	0.0005	0.0013	0.0009	0.0004	0.0008	−0.0015	0.0001	−0.0018	−0.0013
t-stats	−0.3112	−0.0694	0.4893	1.9604	1.7711	0.6008	0.9187	−1.6993	0.0961	−1.0727	−0.4035

(d)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0012	−0.0005	−0.0003	0.0015	0.0008	0.001	0.0014	0.0009	0.0001	−0.0036	−0.0024
t-stats	−0.5893	−0.378	−0.3095	2.2714	1.2824	1.2725	1.7815	0.8962	0.1116	−1.8492	−0.6845
ff3 alpha	−0.0008	−0.0004	−0.0005	0.0009	0.0006	0.0008	0.0011	0.0006	0.0003	−0.0024	−0.0015
t-stats	−0.4371	−0.3473	−0.5398	1.5956	1.0262	1.029	1.373	0.5749	0.221	−1.3715	−0.4521

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0006	−0.0004	0.001	0.0015	0.0007	0.0013	0.0008	−0.0001	−0.0003	−0.0038	−0.0032
t-stats	−0.3382	−0.3536	0.8891	1.9663	1.2633	1.8728	0.9352	−0.0829	−0.2229	−1.9602	−0.9049
ff3-alpha	−0.0004	−0.0005	0.0006	0.0011	0.0004	0.0009	0.0007	−0.0002	0.0001	−0.0025	−0.002
t-stats	−0.235	−0.4841	0.5709	1.4862	0.9096	1.4016	0.8125	−0.243	0.0483	−1.4328	−0.606

Table 5. 120-day momentum. (a) size; (b) bm; (c) beta; (d) str; (e) illiq.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.002	−0.0009	−0.0003	0.0017	0.0008	0.001	0.0023	0.0004	−0.0002	−0.0025	−0.0005

Continued

t-stats	−1.3982	−0.8059	−0.2999	1.9126	1.0487	1.3769	3.139	0.5275	−0.1667	−1.3053	−0.1867
ff3-alpha	−0.0029	−0.0016	−0.0007	0.0014	0.0005	0.0008	0.0022	0.001	0.0005	−0.0011	0.0018
t-stats	−1.8877	−1.3997	−0.758	1.8758	0.666	1.2592	3.1171	1.1819	0.4803	−0.6562	0.6485

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0019	−0.0011	0.0002	0.0012	0.0008	0.0024	0.0007	0.0009	−0.0007	−0.0024	−0.0005
t-stats	−1.2176	−1.0292	0.2209	1.7473	1.1916	3.3639	0.9359	0.9588	−0.6296	−1.4301	−0.1591
ff3-alpha	−0.0027	−0.002	−0.0003	0.0008	0.0003	0.0025	0.0007	0.0014	0.0001	−0.0007	0.002
t-stats	−1.5855	−1.7942	−0.3553	1.243	0.6317	3.4561	0.9847	1.537	0.0678	−0.428	0.6818

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0009	−0.0014	0.0003	0.0013	0.001	0.0014	0.0006	−0.0001	0.0003	−0.0024	−0.0015
t-stats	−0.578	−1.1583	0.3076	1.672	1.3019	1.8753	0.8368	−0.1479	0.2613	−1.1406	−0.4569
ff3-alpha	−0.0017	−0.002	−0.0003	0.0007	0.0006	0.001	0.0007	0.0002	0.0015	−0.0005	0.0012
t-stats	−1.0205	−1.8514	−0.3075	1.0938	0.8619	1.5668	0.8956	0.2255	1.2518	−0.2906	0.3942

(d)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.002	−0.0015	0.0005	0.0005	0.0016	0.0023	0.0018	0.001	−0.0006	−0.0034	−0.0014
t-stats	−1.1514	−1.2594	0.5756	0.5565	2.23	3.3751	2.3344	1.0407	−0.4572	−1.4981	−0.3955
ff3-alpha	−0.0028	−0.0022	−0.0003	0	0.0012	0.0021	0.0017	0.0013	0.0004	−0.0012	0.0015
t-stats	−1.5001	−1.726	−0.4376	−0.029	1.7952	3.0038	2.2175	1.4774	0.3545	−0.6282	0.446

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.002	−0.0001	−0.0002	0.0017	0.0017	0.0019	0.0002	0.0016	−0.0021	−0.0027	−0.0007
t-stats	−1.1589	−0.0528	−0.2193	2.1108	2.194	2.3711	0.2971	1.6896	−1.6272	−1.2543	−0.2182
ff3-alpha	−0.0028	−0.0011	−0.0008	0.0012	0.001	0.0015	0.0002	0.0021	−0.0009	−0.0003	0.0025
t-stats	−1.5545	−0.9501	−0.9353	1.8089	1.5524	2.0002	0.2713	2.1592	−0.7474	−0.1819	0.7977

Table 6. 250-day momentum. (a) size; (b) bm; (c) beta; (d) str; (e) illiq.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.000	0.0003	0.0003	0.0004	0.0024	0.001	−0.0003	0.0001	−0.001	−0.0033	−0.0034
t-stats	0.0915	0.233	0.3128	0.5255	3.552	1.8938	−0.3788	0.1457	−0.8692	−1.635	−1.0287
ff3-alpha	−0.0004	−0.0001	−0.0002	0	0.0023	0.0007	0	0.0003	−0.0004	−0.0022	−0.0019
t-stats	−0.241	−0.1357	−0.2693	0.0379	3.696	1.3319	−0.0291	0.4148	−0.38	−1.393	−0.6634

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0004	0.0002	0.0002	0.0013	0.0011	0.0009	0.0012	−0.0001	−0.0011	−0.0042	−0.0046
t-stats	0.2774	0.1645	0.2756	1.6945	1.9339	1.5919	1.6897	−0.1105	−1.0122	−2.7354	−1.6767
ff3-alpha	0.0002	−0.0004	−0.0005	0.001	0.0008	0.0007	0.0013	0	−0.0003	−0.0027	−0.0029
t-stats	0.1203	−0.3844	−0.8516	1.2035	1.3201	1.3234	1.8821	−0.0049	−0.3018	−1.9742	−1.107

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess-rturn	−0.000	0.0004	0.0008	0.0009	0.0007	0.0017	0.0003	−0.0001	−0.0008	−0.0038	−0.0037
t-stats	−0.0587	0.3676	0.9681	1.1385	0.9753	2.4432	0.4075	−0.0685	−0.6275	−1.7581	−1.1433
ff3-alpha	−0.0004	0.0002	0.0004	0.0004	0.0004	0.0012	0	0	−0.0001	−0.002	−0.0015
t-stats	−0.2929	0.1898	0.4637	0.5332	0.6589	1.8835	0.0111	0.0101	−0.1209	−1.1274	−0.5453

(d)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0005	0.001	0.0005	0.0007	0.0024	0.0021	0.0002	−0.0001	−0.0013	−0.0059	−0.0064
t-stats	0.3197	0.7822	0.5857	0.9174	2.8793	3.0296	0.3003	−0.0891	−1.0039	−2.6195	−1.841
ff3-alpha	0.0003	0.0003	0	0.0001	0.0019	0.0016	0.0001	−0.0001	−0.0005	−0.0037	−0.004
t-stats	0.188	0.2538	−0.0604	0.1691	2.5998	2.5973	0.1862	−0.0658	−0.3638	−2.1062	−1.2844

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0009	0.0009	0.0008	0.0018	0.002	0.0013	0.0002	−0.0005	−0.0022	−0.0053	−0.0061
t-stats	0.5195	0.7041	1.0247	1.7957	2.6327	1.863	0.3054	−0.4846	−1.7031	−2.3833	−1.7873
ff3-alpha	0.0005	0.0001	0.0004	0.0009	0.0015	0.0008	0.0001	−0.0004	−0.0009	−0.0029	−0.0034
t-stats	0.3217	0.0534	0.6308	1.0828	2.3654	1.1614	0.1413	−0.4893	−0.8308	−1.7139	−1.1766

Table 7. 250-day high. (a) size; (b) bm; (c) beta; (d) str; (e) illiq.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0041	0.0025	0.001	−0.0007	−0.0002	−0.0005	0.0002	−0.0001	−0.0022	−0.0042	−0.0083
t-stats	1.8024	1.5801	0.7901	−0.9148	−0.3108	−0.8267	0.2417	−0.119	−1.2451	−1.6978	−1.8202
ff3-alpha	0.0028	0.0017	0.0004	−0.001	−0.0004	−0.0006	0.0005	0.0006	−0.0014	−0.0028	−0.0056
t-stats	1.2017	1.1157	0.3241	1.377	−0.5657	−0.9225	0.5773	0.5186	−0.8166	−1.1922	−1.2474

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0042	0.0024	0.001	0.0009	−0.0011	−0.0005	−0.0009	−0.0001	−0.0012	−0.0048	−0.009

Continued

t-stats	1.7074	1.5477	0.8748	1.1836	−1.6048	−0.6312	−0.9617	−0.1044	−0.6625	−1.9253	−1.9111
ff3-alpha	0.0026	0.0014	0	0.0002	−0.0014	−0.0006	−0.0005	0.0005	0.0001	−0.0024	−0.005
t-stats	1.0693	0.948	0.0213	0.243	−2.2114	−0.8637	−0.5524	0.4671	0.0541	−1.0792	−1.1244

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0048	0.0023	0.0013	0.0004	−0.0003	−0.0007	−0.0005	−0.001	−0.0014	−0.0045	−0.0093
t-stats	2.0113	1.2717	1.0938	0.3893	−0.5054	−1.0015	−0.6344	−0.7896	−0.7989	−1.4789	−1.7893
ff3-alpha	0.0032	0.0012	0.0003	−0.0002	−0.0008	−0.0011	−0.0004	−0.0002	−0.000	−0.0018	−0.0051
t-stats	1.3839	0.7104	0.2625	−0.205	−1.5304	−1.5164	−0.499	−0.1311	−0.0483	−0.701	−1.0682

(d)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0008	0.0003	0.0001	0.0009	0	0.0004	0.0007	0.0017	−0.0004	0.0001	−0.0006
t-stats	0.3512	0.1832	0.0633	1.066	−0.036	0.5342	0.8745	1.3404	−0.2746	0.0642	−0.1505
ff3-alpha	−0.0007	−0.0008	−0.001	0	−0.0005	0	0.001	0.0023	0.0006	0.0028	0.0035
t-stats	−0.3143	−0.638	−1.0228	−0.006	−0.852	−0.0303	1.2673	2.0188	0.4755	1.4784	0.9174

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	0.0039	0.0024	0.001	0.0001	−0.0005	−0.0006	−0.0005	−0.0009	−0.0014	−0.0038	−0.0077
t-stats	1.5505	1.4422	0.9452	0.1417	−0.6512	−0.8604	−0.6118	−0.8392	−0.7184	−1.3128	−1.4903
ff3-alpha	0.0024	0.0013	0.0001	−0.0005	−0.0009	−0.001	−0.0003	−0.0001	−0.0001	−0.0011	−0.0035
t-stats	0.9835	0.8195	0.1419	−0.6736	−1.4123	−1.6849	−0.3011	−0.1126	−0.0537	−0.4276	−0.7298

Table 8. VAR. (a) size; (b) bm; (c) beta; (d) str; (e) illiq.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0002	0.0014	0.0003	0.0011	0.0007	0.0009	0.0002	0.0005	−0.0014	−0.0032	−0.0029
t-stats	−0.1432	1.1662	0.3242	1.4265	1.0917	1.377	0.3001	0.5358	−1.188	−1.9599	−0.9584
ff3-alpha	0.0009	0.0022	0.0009	0.0014	0.0007	0.0007	0	0	−0.0021	−0.0046	−0.0055
t-stats	0.6983	2.1927	1.1063	1.9918	1.1185	1.0351	−0.0422	0.0319	−1.9611	−3.4016	−2.3611

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0029	−0.0013	−0.0001	0	0.0006	0.0004	0.0009	0.0012	0.0009	0.0004	0.0032
t-stats	−1.6569	−1.1231	−0.103	0.0086	1.1065	0.7578	1.0056	1.2178	0.7811	0.2265	1.0496
ff3-alpha	0.0001	0.0006	0.0008	0.0004	0.0004	0.0001	0	0.0002	−0.0006	−0.0019	−0.0021
t-stats	0.1089	0.6409	0.8283	0.4757	0.7846	0.2491	−0.0525	0.2787	−0.7419	−1.4162	−0.9232

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0026	−0.0008	0	0.0013	0.0006	−0.0001	0.0016	0.0013	−0.0001	−0.0011	0.0015
t-stats	−1.0977	−0.5278	0.0295	2.112	0.8653	−0.2368	1.6526	1.3598	−0.0968	−0.542	0.3866
ff3-alpha	0.0004	0.0012	0.0011	0.0015	0.0004	−0.0006	0.0006	−0.0001	−0.0013	−0.0031	−0.0035
t-stats	0.2814	1.2246	1.4809	2.1683	0.5973	−0.8847	0.8078	−0.1409	−1.2218	−1.8752	−1.3771

(d)

	Portl	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0018	0.0001	0.0005	0.0012	0.001	0.0013	0.0006	0.0008	−0.0007	−0.0028	−0.001
t-stats	−0.9395	0.0441	0.6283	1.736	1.9305	1.8667	0.8687	0.7591	−0.5813	−1.4426	−0.2829
ff3-alpha	0.0008	0.0017	0.0014	0.0016	0.001	0.0008	−0.0002	−0.0003	−0.0021	−0.0046	−0.0055
t-stats	0.6281	1.6664	1.8583	2.7135	1.9357	1.1489	−0.3291	−0.3908	−2.2339	−3.2498	−2.3421

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0014	−0.0003	0.0004	0.001	0.0001	0.001	0.0011	0.0004	−0.0006	−0.0017	−0.0003
t-stats	−0.7038	−0.2374	0.4865	1.5813	0.0762	1.6887	1.5334	0.4159	−0.4155	−0.8914	−0.0962
ff3-alpha	0.0009	0.0013	0.0011	0.0014	0	0.0006	0.0006	−0.0006	−0.0019	−0.0034	−0.0043
t-stats	0.7247	1.3912	1.4598	2.072	0.0336	1.2011	0.8983	−0.6227	−1.9297	−2.1379	−1.7596

Table 9. ES. (a) size; (b) bm; (c) beta; (d) str; (e) illiq.

(a)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0002	0.001	0.0016	0.0016	0.0003	0.0007	0	0.0008	−0.0021	−0.0036	−0.0034
t-stats	−0.0882	0.7377	2.3409	2.6362	0.4844	1.1417	0.0329	0.6225	−1.8105	−2.4221	−1.1622
ff3-alpha	0.0013	0.0018	0.0023	0.0019	0.0002	0.0006	−0.0005	−0.0001	−0.0027	−0.0047	−0.0061
t-stats	0.9956	1.771	3.128	3.2153	0.378	1.1336	−0.683	−0.1198	−2.5424	−3.8965	−2.6807

(b)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0024	−0.0012	0	−0.0002	0.001	0.001	0.0009	0.0012	0.0008	−0.001	0.0013
t-stats	−1.2727	−0.9332	−0.0427	−0.256	1.9786	1.4754	1.0263	1.1083	0.7392	−0.6656	0.4186
ff3-alpha	0.0008	0.0006	0.0008	0.0001	0.0007	0.0005	0.0004	0	−0.0006	−0.0033	−0.0042
t-stats	0.6113	0.6121	1.109	0.1361	1.4314	0.796	0.4297	0.0345	−0.6307	−2.5355	−1.7703

(c)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0025	−0.0001	−0.0002	0.0012	0.0004	0.0007	0.001	0.0014	0.0004	−0.0021	0.0004

Continued

t-stats	−0.9784	−0.0812	−0.1958	1.5512	0.6142	0.9688	0.9618	1.1116	0.2762	−1.1275	0.1102
ff3-alpha	0.0009	0.0019	0.0008	0.0015	0	0	0	0.0001	−0.0009	−0.0042	−0.0051
t-stats	0.5884	2.0154	1.0874	1.8335	−0.0634	−0.0172	0.0455	0.1015	−0.8561	−2.7312	−2.0031

(d)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0011	0.0001	0.0007	0.001	0.001	0.0008	0.0014	0.0004	−0.0007	−0.0036	−0.0025
t-stats	−0.5445	0.0672	0.9209	1.2354	1.7661	1.2505	1.7145	0.375	−0.5198	−2.0502	−0.699
ff3-alpha	0.0017	0.0021	0.0017	0.0012	0.0009	0.0002	0.0004	−0.0006	−0.002	−0.0055	−0.0072
t-stats	1.2343	1.8953	2.4151	1.6591	1.5078	0.2744	0.5387	−0.7544	−2.0271	−4.0062	−3.083

(e)

	Port1	Port2	Port3	Port4	Port5	Port6	Port7	Port8	Port9	Port10	High-Low
excess return	−0.0012	0.0002	0.0001	0.0013	0.0007	0.0008	0.0003	0.0007	−0.0006	−0.0022	−0.001
t-stats	−0.5839	0.1143	0.1679	1.8789	1.2733	1.1812	0.3162	0.5502	−0.4756	−1.2704	−0.2926
ff3-alpha	0.0014	0.0019	0.0008	0.0014	0.0007	0.0005	−0.0004	−0.0003	−0.0018	−0.0041	−0.0055
t-stats	0.9712	1.9295	1.0732	2.0346	1.238	0.7178	−0.5349	−0.3066	−1.7963	−2.7925	−2.2012

stocks with the highest momentum in each firm-specific attribute decile. For each combination, the panel displays the excess return and alpha for the upcoming month, along with the corresponding High-Low indicator. The alpha is calculated based on the abnormal return derived from the Fama-French three-factor model. The t-statistic is adjusted using the Newey-West method, enhancing the robustness of the results.

Table 5 presents results from the value-weighted bivariate portfolios based on dependent double sorts of various firm-specific attributes and 120-day momentum between 2009 and 2022.

Table 6 presents results from the value-weighted bivariate portfolios based on dependent double sorts of various firm-specific attributes and 250-day momentum between 2009 and 2022.

Table 7 presents results from the value-weighted bivariate portfolios based on dependent double sorts of various firm-specific attributes and 250-day high momentum between 2009 and 2022.

Table 8 presents results from the value-weighted bivariate portfolios based on dependent double sorts of various firm-specific attributes and VaR between 2009 and 2022.

Table 9 presents results from the value-weighted bivariate portfolios based on dependent double sorts of various firm-specific attributes and ES between 2009 and 2022.

4.4. Firm-Level Cross-Sectional Regression Analysis

The firm-level cross-sectional regression is conducted on a monthly basis, with the dependent variable being each stock's excess return for the subsequent month. The independent variables include the lagging study variable along with various company-specific control variables. This regression analysis results in six panel results in total. Each panel presents the estimated results for one-month-ahead returns using the ordinary least squares (OLS) methodology. The reported coefficients represent the time series mean of the monthly Fama and MacBeth (1973) regression. The t-statistic, shown in parentheses, is adjusted using the Newey and West (1987) adjustment method.

In the cross-sectional regression analysis of traditional cross-sectional momentum, we find that the returns over the past 60 days, 120 days, and 250 days have a negative impact on the one-month-ahead returns, with t-statistics ranging from −2 to 0. This suggests a weak reversal effect. Conversely, 60-day momentum and 250-day momentum exhibit higher t-statistics and strong significance, indicating a significant medium and long-term reversal effect in stocks. Among all the regressions, the market value factor, lagging one-month rate of return, and illiquidity indicators display strong significance. This implies that these three factors possess considerable explanatory power for expected returns compared to other factors. In addition to these factors, the momentum factor still holds explanatory power for one-month-ahead returns, albeit not as strong as the aforementioned factors.

In the first column of Panel (d), the univariate regression coefficient for anchor is −0.0211, with a corresponding t-statistic of −1.334. Columns 2 to 13 systematically enhance the explanatory power of the univariate regression by sequentially adding additional company-specific attribute variables to the independent variable. In the aforementioned regression, the coefficient for anchor ranges from −0.0211 to 0.0045, with t-statistics ranging from −1.548 to 0.4292. The study reveals that in the first four columns of the regression, the coefficient for anchor is significantly negative. This suggests that a higher 52 Week High is associated with a smaller one-month-ahead return. However, after the inclusion of str and illiq variables, the coefficient for anchor becomes positive and insignificant. This may potentially be attributed to the issue of missing variables in the previous models. Notably, the t-statistics for str and illiq range from 4 to 7, indicating their statistical significance. The regression analysis indicates that the market value factor, past month returns, and illiquid indicator serve as robust and strong predictors of expected returns. However, after accounting for other determinants of stock returns, an unstable negative correlation is observed between anchor and expected returns.

In Panels (e) and (f), as the univariate regression is gradually strengthened, we observe a gradual increase in the significance of VaR and ES, with t-statistics reaching approximately −3. The coefficient for VaR ranges from −0.2748 to 0.0332, while the coefficient for ES ranges from −0.2739 to 0.0043. These coefficients are significantly negative, indicating that higher levels of left-tail risk are associated with lower one-month-ahead returns. This highlights the explanatory power of left-tail risk in predicting expected returns and the presence of left-tail momentum. Several noteworthy observations are related to the control variables. Firstly, the coefficient for the market value factor regression ranges from −0.0061 to 0.0053, with t-statistics ranging from −4.5363 to 3.8553. This indicates a strong negative correlation between the market value factor and the subsequent month's return. Secondly, the past month's return also exhibits a strong negative correlation with the next month's return, suggesting a short-term reversal effect. Additionally, higher values of illiq are associated with greater expected returns, indicating a negative correlation between stock liquidity and expected returns. Comparing multiple regression models, we find that single variables such as VaR and ES don't strongly explain the dependent variable. However, there is a substantial improvement in explanatory power after introducing multiple control variables, suggesting potential issues of collinearity in the regression analysis.

Table 10 presents the cross-sectional regression results for the one-month-ahead excess returns of stocks from 2009 to 2022. The regression analysis utilizes the Ordinary Least Squares method. The coefficients reported in Table 10 represent the average values from the time series of Fama-MacBeth regressions conducted for each month. The corresponding t-statistics are adjusted using the Newey-West method to account for potential heteroscedasticity and autocorrelation. The Avg R^2 is calculated as the average value obtained from the time series of R-squared values.

4.5. Sources of Left-Tail Momentum

To provide an explanation for the presence of left-tail momentum, we propose behavioral explanations for the observed lower expected returns of stocks with higher left-tail risk. Our research is primarily grounded in the notion that investors tend to underestimate the persistence of left-tail risk and overvalue stocks that have recently suffered significant losses. We posit that stocks with higher left-tail risk have recently experienced substantial losses, and investors have underestimated the likelihood of these losses continuing. Consequently, investors end up paying a premium for these stocks. However, when the losses persist into the future, the returns on these stocks tend to be lower. To investigate this further, we calculate the change in value at risk (Delta VaR) for each stock between month t and month t − 1, denoted as Delta VaR = $VaR_t - VaR_{t-1}$. We then employ Delta VaR and VaR to partition the group in a bivariate portfolio analysis to examine if Delta VaR has an impact on the return at month t + 1.

For each stock, the Delta VaR value can take on negative, zero, or positive values in a given month. A negative Delta VaR indicates that VaR_t is less than VaR_{t-1}, implying that the first percentile of daily returns for the year preceding the end of month t is lower than the first percentile of daily returns for the year preceding the end of month t − 1. This signifies that the stock has experienced a significant decline during the t − 12 month period. Conversely, a positive Delta VaR suggests that VaR_t is greater than VaR_{t-1}, indicating that the stock has encountered a sharp decline during the t month. Lastly, when VaR_t equals VaR_{t-1},

Table 10. Firm-level cross-sectional regressions.

(a)

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0166	0.0194	0.1196	0.1275	0.1102	0.1019
	(2.7198)	(3.4385)	(3.4128)	(3.6742)	(3.0336)	(2.8349)
mom60	−0.008	−0.0082	−0.0064	−0.0059	−0.0093	−0.0092
	(−1.3199)	(−1.3768)	(−1.1731)	(−1.1592)	(−1.6515)	(−1.6477)
beta		−0.0038	0.0007	0.0009	−0.001	−0.0001
		(−0.8746)	(0.1632)	(0.225)	(−0.2555)	(−0.0217)
size			−0.0047	−0.0051	−0.0043	−0.0041
			(−3.1894)	(−3.5569)	(−2.8886)	(−2.7397)
bm				0.0063	0.0036	0.0051
				(1.3905)	(0.7865)	(1.1598)
str					−0.0548	−0.0537
					(−5.1916)	(−5.1148)
illiq						0.1161
						(4.5933)
Avg. R^2	0.0148	0.0299	0.0532	0.0659	0.0806	0.083

(b)

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0191	0.0224	0.133	0.1419	0.1241	0.1154
	(3.0708)	(3.7329)	(3.8092)	(4.0864)	(3.4193)	(3.2197)
mom120	−0.0037	−0.0029	−0.0017	−0.0011	−0.0036	−0.0036
	(−0.9457)	(−0.7588)	(−0.4478)	(−0.3535)	(−1.0276)	(−1.0277)
beta		−0.0049	−0.0001	0.0001	−0.0016	−0.0007
		(−1.0344)	(−0.0219)	(0.0293)	(−0.3934)	(−0.1594)
size			−0.0052	−0.0056	−0.0048	−0.0045
			(−3.5816)	(−3.9807)	(−3.2787)	(−3.1258)
bm				0.0061	0.003	0.0046
				(1.3835)	(0.6526)	(1.0352)
str					−0.0538	−0.0525
					(−5.0593)	(−4.9704)
illiq						0.1173
						(4.5747)
Avg. R^2	0.0139	0.0297	0.053	0.065	0.0797	0.0822

(c)

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0183	0.0223	0.1377	0.144	0.126	0.117
	(3.2253)	(3.6672)	(3.8595)	(4.0367)	(3.3922)	(3.1858)
mom250	−0.0056	−0.0048	−0.0033	−0.0028	−0.0044	−0.0044
	(−1.7259)	(−1.6363)	(−1.0925)	(−1.1003)	(−1.597)	(−1.6153)
beta		−0.0052	−0.0002	0.0005	−0.0009	0.0001
		(−1.2152)	(−0.0427)	(0.1451)	(−0.2425)	(0.0191)
size			−0.0054	−0.0057	−0.0049	−0.0046
			(−3.6515)	(−3.9343)	(−3.2557)	(−3.0979)
bm				0.0041	0.0011	0.0028
				(0.9612)	(0.2611)	(0.6628)
str					−0.052	−0.0509
					(−5.0676)	(−4.9734)
illiq						0.1254
						(4.9463)
Avg. R^2	0.0147	0.0306	0.054	0.0647	0.0791	0.0815

(d)

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0279	0.0342	0.1243	0.1348	0.1154	0.1065
	(2.1166)	(2.5012)	(3.3555)	(3.7036)	(3.1975)	(2.9941)
anchor	−0.0211	−0.0211	−0.0189	−0.02	0.0045	0.0042
	(−1.334)	(−1.3901)	(−1.3593)	(−1.548)	(0.4292)	(0.3954)
beta		−0.0079	−0.0036	−0.0032	−0.0014	−0.0004
		(−1.7282)	(−0.8654)	(−0.8194)	(−0.3482)	(−0.1003)
size			−0.0043	−0.0047	−0.0048	−0.0045
			(−3.1232)	(−3.5424)	(−3.5219)	(−3.3467)
bm				0.0051	0.0036	0.0052
				(1.1677)	(0.7931)	(1.2006)
str					−0.054	−0.0527
					(−6.8706)	(−6.7063)
illiq						0.1229
						(4.7791)
Avg. R^2	0.0217	0.0359	0.0568	0.0696	0.0794	0.0818

(e)

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0169	0.0184	0.1514	0.1561	0.1483	0.1383
	(2.9411)	(3.6265)	(4.8111)	(4.9257)	(4.4862)	(4.2423)
var	−0.0058	0.0332	−0.209	−0.1924	−0.2748	−0.2565
	(−0.05)	(0.2417)	(−1.9886)	(−2.231)	(−3.3627)	(−3.1137)
beta		−0.0047	0.0064	0.0059	0.006	0.0065
		(−0.8197)	(1.2411)	(1.2538)	(1.2391)	(1.3586)
size			−0.0058	−0.0061	−0.0056	−0.0053
			(−4.3732)	(−4.5363)	(−4.0396)	(−3.8553)
bm				0.003	−0.0003	0.0015
				(0.6611)	(−0.0604)	(0.3571)
str					−0.051	−0.0499
					(−5.2714)	(−5.1593)
illiq						0.1125
						(4.4644)
Avg. R^2	0.0234	0.0396	0.0571	0.0669	0.0801	0.0824

(f)

	(1)	(2)	(3)	(4)	(5)	(6)
const	0.0186	0.0191	0.1584	0.1626	0.1551	0.1456
	(3.0242)	(3.2748)	(5.1319)	(5.2002)	(4.7599)	(4.5150)
es	−0.0177	0.0043	−0.2268	−0.2092	−0.2739	−0.2613
	(−0.1881)	(0.0352)	(−2.3241)	(−2.5070)	(−3.4313)	(−3.2308)
beta		−0.0033	0.0080	0.0076	0.0077	0.0083
		(−0.5087)	(1.3360)	(1.3671)	(1.3509)	(1.4579)
size			−0.0059	−0.0062	−0.0057	−0.0055
			(−4.5827)	(−4.7154)	(−4.2174)	(−4.0360)
bm				0.0031	0	0.0017
				(0.7016)	(−0.0015)	(0.4000)
str					−0.0512	−0.0501
					(−5.3068)	(−5.1993)
illiq						0.1090
						(4.3550)
Avg. R^2	0.0221	0.0399	0.0574	0.0675	0.0809	0.0832

Note: mom60, mom120, mom250 are 60-day momentum, 120-day momentum, 250-day momentum.

it implies that the most substantial declines for both variables occur within the same month range.

Left-tail risk is a persistent characteristic of equities, whereby stocks that undergo substantial daily losses in month t of portfolio formation are expected to continue experiencing significant losses in the future. In cases where Delta VaR is positive, indicating a sharp decline in month t, we anticipate a more pronounced negative correlation between expected returns and VaR in equity portfolios. In Panel (a), we sort stocks into five equal parts based on the VaR value each month. Within each portfolio, we further divide them into three groups based on the positive or negative signs of Delta VaR. This process results in a 5 × 3 portfolio configuration, allowing us to calculate the difference in expected returns for the VaR division portfolio under various Delta VaR symbols. As observed in Panel (a), the High-Low for the stock portfolio that experienced significant losses in month t − 12 is −0.39%, with a t-statistic of −1.1998. Conversely, the High-Low for the stockholding portfolio that encountered larger losses in month t is −0.19%, with a t-statistic of −0.4556. Interestingly, we find that the expected returns don't exhibit a strong negative correlation with left-tail risk in the equity portfolios that experienced significant losses in month t. This phenomenon may be attributed to a reversal in investor behavior, wherein the persistence of stock declines is no longer underestimated, and the level of mean reversion is no longer overestimated. Consequently, the probability of overvaluing securities with high left-tail risk and near-term capital loss diminishes. The emergence of this phenomenon could be linked to the decline in the ratio of retail investors to institutional investors and the improvement of investor literacy.

To enhance the robustness of our findings, we introduce Lagged Delta VaR with a lag period for a comprehensive multivariate analysis. Lagged Delta VaR is defined as $VaR_{t-1} - VaR_{t-2}$. A negative Lagged Delta VaR indicates that the stock experienced a significant decline in month t − 13. A positive Lagged Delta VaR suggests a sharp decline occurred in month t − 1. A Lagged Delta VaR of zero indicates that the most substantial declines for both variables occurred within the same month range. In Panel (b), we sort stocks based on their VaR value each month and then divide them into nine groups according to the signs of Delta VaR and Lagged Delta VaR within each portfolio. This results in a 5 × 9 portfolio structure. If a stock portfolio exhibits positive values for both Delta VaR and Lagged Delta VaR, it signifies that the portfolio experienced significant declines in both month t and month t − 1, thereby exacerbating the potential persistence of left-tail risk compared to the findings in Panel (a). By incorporating Lagged Delta VaR into our analysis, we aim to provide a more comprehensive understanding of the relationship between left-tail risk and expected returns. This approach allows us to explore the joint effects of recent and earlier declines on the persistence of left-tail risk.

When both Delta VaR and Lagged Delta VaR are negative, the High-Low value is −0.21%, accompanied by a non-significant t-statistic of −0.6027. However, as Lagged Delta VaR transitions from negative to positive, we observe a gradual increase in the difference between Port5 and Port1, indicating a more pronounced negative correlation between left-tail risk and expected returns in the equity portfolio that experienced a significant decline in month t − 1. In the case where Delta VaR is positive, we find that as Lagged Delta VaR shifts from negative to positive, the High-Low exhibits a decreasing trend from positive to negative. Simultaneously, the significance of the correlation also diminishes. This implies that equity portfolios experiencing larger declines in month t don't exhibit a stronger negative correlation between left-tail risk and expected returns. Although the negative correlation strengthens with a larger decline in month t − 1, the effect remains weak.

Table 11. Delta VaR analysis. (a) Sorts based on delta VaR; (b) Sorts based on Delta VaR and Lagged Delta VaR.

(a)

	Port1	Port2	Port3	Port4	Port5	High-Low	alpha
DeltaVaR < 0	0.0182	0.0218	0.0205	0.0213	0.0171	−0.0039	−0.0016
						(−1.1998)	(−0.4207)
DeltaVaR = 0	0.0181	0.0198	0.0206	0.0222	0.0195	−0.0009	0.0014
						(−0.2890)	(0.3678)
DeltaVaR > 0	0.0178	0.0215	0.0167	0.0167	0.0159	−0.0019	0.0008
						(−0.4556)	(0.1769)

(b)

	Lagged Delta VaR	Port1	Port2	Port3	Port4	Port5	High-Low	alpha
DeltaVaR < 0	negative	0.0169	0.0169	0.0172	0.0183	0.0141	−0.0021	−0.0003
							(−0.6027)	(−0.0759)
	zero	0.0183	0.0205	0.0203	0.0187	0.0161	−0.0037	−0.0004
							(−0.9989)	(−0.0964)
	positive	0.0220	0.0196	0.0181	0.0218	0.0141	−0.0074	−0.0052
							(−1.7451)	(−1.0109)
DeltaVaR = 0	negative	0.0189	0.0161	0.0188	0.0132	0.0152	−0.0021	0.0013
							(−0.4542)	(0.2505)
	zero	0.0127	0.0131	0.0161	0.0204	0.0159	0.0040	0.0058
							(0.8668)	(1.2021)
	positive	0.0188	0.0225	0.0230	0.0185	0.0151	−0.0059	−0.0041
							(−1.1337)	(−0.7856)
DeltaVaR > 0	negative	0.0150	0.0194	0.0171	0.0189	0.0176	0.0023	0.0055
							(0.4604)	(1.0539)
	zero	0.0176	0.0199	0.0189	0.0148	0.0169	0.0014	0.0037
							(0.2959)	(0.7171)
	positive	0.0135	0.0162	0.0076	0.0097	0.0117	−0.0005	0.0029
							(−0.1061)	(0.5816)

Table 11 shows the multivariate sorting combinations based on the size of the stock's Detla VaR, Lagged Detla VaR, and VaR between 2009 and 2022. Detla VaR is defined as the gap between VaR in t and VaR in t − 1, and Lagged Detla VaR is defined as the gap between VaR in t − 1 and VaR in t − 2. In Panel (a), value-at-risk quintiles are formed each month and stocks are classified based on whether their Delta VaR is negative, zero, or positive into three groups in each VaR1 quintile. In Panel (b), the stocks are classified based on whether their Delta VaR and Lagged Delta VaR are negative, zero, or positive into nine groups in each VaR1 quintile. Each Panel reports the portfolio's excess returns and ff3-alpha for the coming month, with the t-statistic in parentheses adjusted by Newey-West.

5. Conclusion

In our empirical research, we initiated our analysis with a descriptive statistical review and correlation coefficient matrix for each variable. We observed minimal time correlation amongst the studied variables. Notably, VaR and ES demonstrated a strong correlation. When VaR was the focal point of our research, we identified that smaller companies and stocks with higher market beta, lower book-to-market ratio, and increased mobility exhibited heightened left-tail risk. In contrast, larger enterprises and stocks with diminished market beta, lower book-to-market ratio, and reduced mobility registered a more elevated 52-Week High. For traditional cross-sectional momentum, all time horizon variables presented a negative correlation with market beta and book-to-market ratio. Bigger companies manifested higher traditional cross-sectional momentum size alongside increased market beta and mobility.

Our univariate ranking sought to elucidate the relationship between the three momentum factors and future stock returns. By segmenting stocks based on their momentum load, we adopted a long-short strategy—buying stocks with the highest momentum values while shorting those with the lowest. Interestingly, for the 60-day momentum, the subsequent excess return pattern was U-shaped relative to the number of portfolios. However, portfolios at the extremities of the 60-day momentum did not register significant excess returns. To delve deeper into the 60-day momentum's predictive power on future stock returns, we evaluated its performance using widely acknowledged asset pricing models, such as Fama and French (1993). Our empirical findings indicated a U-shaped relationship between ff3-alpha and the number of the corresponding portfolio. Notably, stocks with elevated 60-day momentum recorded depressed future returns. This cross-sectional reversal pattern was only mildly affected under the ff3 model. Similar U-shaped patterns were discerned for the 120-day and 250-day momentum groups. With the 250-day high momentum, an incremental momentum rise correlated with declining excess and abnormal returns. The zero-cost portfolio's reversal effect in the zero-cost portfolio was still weak.

Our examination of the VaR and ES factors revealed that zero-cost portfolios focusing on VaR or ES barely generated excess returns close to 0. However, when considering the ff3 factor's negative correlation with left-tail momentum, the anomaly return emerged as significantly positive. Consequently, we inferred that while the left-tail momentum effect within China's A-share market isn't overwhelmingly potent, it certainly exists.

Our univariate ordering detected faint reversal effects for cross-sectional momentum and 250-day high momentum, and a reasonably distinct left-tail momentum impact. Nonetheless, these outcomes could stem from other factors specific to individual firms. Addressing this, we employed a bivariate ranking analysis. After accounting for variable size, the zero-cost portfolio yielded an average excess return of 0.55%. This further underscored the positive, albeit mild, relationship between left-tail momentum and future returns within China's A-share market.

Subsequently, our cross-sectional regression at the firm level for each month revealed that, aside from the three predominant factors (market value, one-month lagged returns, and illiquidity indicators), the momentum factor also played a role in explaining expected returns, albeit modestly. During our iterative regression enhancements, VaR and ES's significance progressively amplified, reflecting the explanatory prowess of left-tail risk regarding expected returns and the presence of left-tail momentum.

To comprehend left-tail momentum's existence, we postulated a behavioral perspective, hypothesizing that investor tendencies to underestimate left-tail risk and overvalue stocks with significant recent losses might explain why stocks with elevated left-tail risk yield lesser expected returns. Empirical examinations corroborated that, even after introducing a lagged Delta VaR for more robust results, the relationship between left-tail risk and expected returns, especially for stocks with recent substantial losses, still showed a weak negative correlation.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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