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ORIGINAL RESEARCH

Capital investment and momentum strategies

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Abstract The main purpose of this paper is to investigate whether capital investment can affect stock price momentum. We provide empirical evidence that momentum strategies tend to be more profitable for stocks with large capital investment or investment changes. We present a simple explanation for our empirical results and show that our finding is consistent with the behavioral finance theory that characterizes investors' increased psychological bias and the more limited arbitrage opportunity when the estimation of firm value becomes more difficult or less accurate.

Keywords Capital investment · Momentum strategy · Momentum profit · Behavioral finance

JEL Classification G11 · G12 · G14 · M41

1 Introduction

It has long been recognized by financial economists and practitioners that capital investment affects future cash flows and asset risk, and thus can have a significant impact on future stock returns. For example, recent studies by Fairfield et al. (2003) and Titman et al. (2004) show that capital investment can help to predict future stock returns in cross-sectional analysis. In particular, low investment stocks tend to have significantly higher

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future stock returns than high investment stocks. However, little is known about whether or not past capital investment can interact with past stock returns to help predict future stock returns, that is, whether or not past capital investment affects stock price momentum.

In this paper, we jointly study capital investment and momentum strategies to examine whether or not past capital investment can interact with past stock returns to help predict future stock returns. Specifically, we address two research questions. First, we empirically examine how the interaction of past capital investment and stock returns helps to predict future stock returns. Second, we present a simple explanation to help understand the economic intuition behind our empirical findings.

The motivation of our study of the impact of capital investment on momentum strategies stems from the following three reasons. First, while capital investment and stock price momentum have been extensively studied in corporate finance and asset pricing literatures, to our best knowledge, they have never been jointly studied. Thus our paper is the first to jointly study capital investment and momentum profit effect. This joint study can provide a great opportunity to gain insights into how stock price momentum effect may be related to firms' fundamental activity of capital investment, and thus better understand stock price momentum in finance. Second, unlike state variables used in previous price momentum empirical studies such as earnings (Chan et al. 1996; Chordia and Shivakumar 2006; Griffin et al. 2005), revenue surprise (Jegadeesh and Livnat 2006), growth options (Sagi and Seasholes 2007), order backlogs (Gu and Huang 2010) and speculative intensity (Hoitash and Krishnan 2008), capital investment is a decision variable that is related to the firm-level investment decision. Thus the study of capital investment points to the direct impact of the fundamental economic activity on price momentum effect. Third, capital investment is closely related to capital budgeting, an important research topic in corporate finance. On the other hand, stock price momentum is an important piece of empirical evidence, which is challenging the market efficiency hypothesis in modern asset pricing theory (Yen and Lee 2008). Therefore, the study of the impact of capital investment on momentum trading strategies can link capital budgeting in corporate finance and momentum price effect in asset pricing, a first attempt in this direction.

We use three ways to measure firms' capital investment. First, we use scaled annual capital expenditure (I). Second, we use the change of scaled annual capital expenditure (IC) between 2 years. Finally, we use scaled annual total accruals (Accr). The first two measurements of capital investment, I and IC, are related to firms' capital investment in long-term assets. The third measurement is associated with firms' capital investment in working capital, or short-term assets. While capital investment is often measured by firms' investment in long-term assets in most previous studies, the consideration of capital investment in both short-term and long-term assets is to provide a more complete understanding on how firms' different capital investments affect stock price momentum profit.

We use past capital investment and stock returns to independently sort stocks into five capital investment portfolios and five momentum portfolios, respectively. This independent sort yields 25 capital investment and momentum portfolios. Using three different measurements of capital investment, we find that capital investment has a significant impact on momentum profit. Specifically, when capital investment is measured by scaled capital expenditure, capital investment has little impact on price momentum when it is from small to median. However, momentum effect monotonically increases when capital investment increases from median to large.

When we use the change of scaled capital expenditure (IC) or annual accruals (Accr) to represent capital investment, the impact of capital investment on momentum profit is not monotonic but exhibits a "U" curve. That is, from the small investment portfolio to the intermediate investment one, momentum effects decrease. From the intermediate investment portfolio to the large one, momentum effects increase.

In addition, regardless of how capital investment is measured, the loser portfolio with the largest capital investment tends to have the smallest return. But the winner portfolios with the smallest accruals or change of scaled capital expenditure always have the largest return. Nevertheless, the winner portfolio with the largest scaled capital expenditure tends to have the largest return in some momentum strategies. Thus, when the interaction between capital investment and momentum strategies is considered, the trading strategy of buying the winner stocks with the smallest accruals or change of scaled capital expenditure, or buying the winner stocks with the largest scaled capital expenditure, and shorting the loser stocks with the largest capital investment can significantly exceed the momentum profit that is obtained when no capital investment is considered. For example, when we use annual accruals to measure capital investment, for momentum portfolios built on past 6-month returns with a 6-month holding horizon, the loser portfolio with the largest capital investment has a smallest monthly return of 0.36% but the winner portfolio with the smallest investment has the largest monthly return of 1.84%. If we buy the stocks in the winner portfolio with the smallest capital investment, and short stocks in the loser portfolio with the largest investment, we will gain a profit of monthly return of 1.48%, which is about 170% of the monthly momentum profit of 0.87% without capital investment considered.

We verify that the impact of capital investment on momentum profit is robust and cannot be explained by other firm characteristics such as firm size and analyst coverage. We also show that higher capital investment tends to be associated with larger uncertainty in future earnings, cash flows and stock returns and more disperse earnings forecast by financial analysts. This property of large uncertainty associated with large capital investment helps to explain the economic intuition behind our empirical findings as follows.

As discussed above, large capital investment tends to be associated with more uncertainty in future earnings, cash flows and stock returns. This increased uncertainty makes it more difficult to estimate firm value. Therefore, large capital investment tends to be associated with less accurate estimation of firm value.

Recently, several behavior finance theories use investors' psychological bias and the limited arbitrage opportunity to argue that security mis-pricing such as momentum effect can become more serious when the estimation of stock value becomes less accurate.[1] Based on these behavior finance theories, firms with large capital investment tend to be linked to less accurate estimation of firm value and hence should exhibit strong momentum effect.

The organization of the rest of the paper is as follows. In the next section, we discuss related work. In Sect. 3, we present our empirical results. Section 4 addresses the economic intuition behind our empirical findings, and conclusions are made in Sect. 5.

2 Related work

We have two main objectives in this study. First, we try to understand how capital investment affects momentum strategies. Second, we try to present a simple explanation to help understand why capital investment can interact with momentum strategies to predict future stock returns. Since there is a huge body of literature on capital investment and stock

[1] Some representative papers in investor's psychological bias are Daniel et al. (1998, 2001); some representative works in the limited arbitrage opportunity are Barberis and Thaler (2003), Mitchell et al. (2002), and Shleifer and Vishny (1997).

price momentum, we don't review the literature in detail, but just briefly discuss the most closely related work.

2.1 Capital investment and future stock returns

Since capital investment is a clear and important economic variable, its impact on future stock returns has been carefully studied in the recent literature. A partial list of these studies includes Fairfield et al. (2003), Titman et al. (2004), Hirshleifer et al. (2004), and Sloan (1996). Fairfield et al. (2003) and Titman et al. (2004) study the impact of capital investment on future stock returns in the time window of 1–3 years. They find that capital investment has a significant impact on subsequent stock returns. In particular, they find that capital investment is negatively correlated with subsequent future returns. That is, small capital investment stocks tend to have larger future returns but large capital investment stocks have smaller future returns. Hirshleifer et al. (2004) examine how cumulative capital investment or net operating assets affect future stock returns and also find that cumulative capital investment has a significant impact on future stock returns. Specifically, they find that cumulative capital investment and future stock returns are negatively correlated. Finally, Sloan (1996) uses annual accruals to measure capital investment and reports that high accrual firms earn lower future stock returns than low accrual firms. While these studies all examine the impact of capital investment on future stock returns, they are different from our work in that we examine how past capital investment and past stock returns can interact to help predict future stock returns.

2.2 Investors psychological biases

Investors' psychological biases such as overconfidence in asset prices have been well studied in the finance literature. Many studies find that investors tend to be biased about the quality of their own information. For example, Griffin and Tversky (1992) show that investors can systematically overweight the types of information such as more salient or less reliable ones, but underweight the types of information such as more abstract or statistical ones. More specifically, several studies, like Hirshleifer (2001), Daniel et al. (1998, 2001) and Odean (1998), develop asset pricing models of investors' overconfidence about their private information and show that these models can help to explain many of the empirically observed stock return properties, such as excessive stock return volatility, predictable cross-sectional future returns and slow price adjustment to public information.

While these studies don't explicitly address the research question in this paper, they help to shed some light on how capital investment impacts investors' psychological bias such as overconfidence in the following direction. They argue that when it is more difficult to estimate security value, investors' psychological biases will become more serious and then security mis-pricing such as momentum effects will become stronger. As will be shown in our empirical analysis, large capital investment stocks tend to be associated with less accurate value estimation. Therefore, for large capital investment stocks, momentum effects are stronger.

2.3 The limited arbitrage opportunity

Another theory that helps in understanding our empirical finding is the limited arbitrage opportunity idea, which argues that when stock value estimation becomes more difficult or less accurate, fully rational investors will face larger costs to implement their momentum strategies. These higher costs could be caused by less accurate estimates of firm value, larger acquisition costs of information and a possibly much slower convergence of stock prices to fundamentals. For example, Shleifer and Vishny (1997), Mitchell et al. (2002), and Barberis and Thaler (2003) show that for stocks with a less accurate value estimation, arbitrageurs tend to face a larger cost of maintaining their position. This is due to the fact that the convergence of stock prices to fundamentals values is more likely to be protracted. This tends to make their arbitrage strategies more risky. As a result, when security value estimation becomes more difficult, there is a more limited arbitrage opportunity and the mis-pricing of stocks such as momentum effect is likely to be more serious, as is the case for the stocks with large capital investment.

3 Empirical findings

In this section, we discuss our empirical findings for the impact of capital investment on momentum strategies. Specifically, we discuss our data and methodology in Sect. 3.1, examine stylized momentum profit in our data in Sect. 3.2, and discuss empirical evidence in Sect. 3.3 about the interaction between capital investment and momentum strategies. Finally in Sect. 3.4–3.6, we check the robustness of our empirical findings.

3.1 Data sample

Our sample includes all firms listed on the NYSE, AMEX, and NASDAQ from January 1965 to December 2004 with at least 2 years of data prior to the portfolio formation date. Our sample excludes the firm that is a prime, a closed-end fund, a real estate investment trust (REIT), an American Depository Receipt (ADR), or a foreign stock. In addition, our sample excludes stocks whose price was less than five dollars as of the portfolio formation date and stocks with less than 24 months of past returns data on CRSP.

Capital investment and past stock returns are measured prior to portfolio formation date t, which is the beginning of a given month in our sample period. In particular, the past stock return is the geometric average return over portfolio formation period J (J = 3, 6, 9 or 12 months) prior to month t. Capital investment is measured in the most recent fiscal year that ended at least four months prior to month t. This 4-month lag after the fiscal year end will assure that investors have access to this kind of information.

As discussed in the introduction, we use three ways to measure capital investment: capital expenditure (COMPUSTAT data 128) scaled by concurrent property, plants and equipments (PPE) (see Kaplan and Zinglales 1997 for using PPE as the scalar), the change of scaled capital expenditure, and annual accruals scaled by total assets. Accruals capture mostly the change of net working capital during a year. We measure accruals following Sloan (1996). To maintain a meaningful sample size, the accrual sample starts from year 1971. In our analysis, we use I, IC and Accr to denote these three capital investment measurements, respectively.

Table 1 reports descriptive statistics and correlation coefficients for capital investment variables, firm size and the stock price by using annual observations. Panel A shows that on average, firms' capital expenditure is 14.6% of PPE. This indicates a fixed-asset turnover rate of about 6.8 years. On the other hand, the average change of capital expenditure is −0.008, not significantly different from zero. This result shows that in general, firms have

Table 1 Descriptive statistics

	Mean	P10	Q1	Median	Q3	P90	SD	Number of firm-years
Panel A: descriptive statistics								
I	0.146	0.044	0.072	0.114	0.183	0.288	0.112	83,946
IC	−0.008	−0.105	−0.038	−0.002	0.029	0.082	0.095	82,776
Accr	−0.024	−0.112	−0.067	−0.029	0.013	0.073	0.082	73,616
Size	1,539.2	19.2	48.5	164.0	656.6	2,348.4	9,250.2	83,938
Price	24.01	7.00	10.31	18.00	30.25	46.13	29.27	83,938

	Size	Price	I	IC	Accr
Panel B: correlation matrix					
Size		0.179	*−0.009*	*0.005*	−0.036
Price	0.659		−0.016	0.034	−0.023
I	0.043	0.019		0.327	0.209
IC	*0.003*	0.062	0.293		0.039
Accr	−0.096	*−0.007*	0.175	0.087	

This table presents summary statistics for the key variables used in this paper. Our sample consists of all firms listed on NYSE/AMEX/NASDAQ between 1965 and 2004, excluding closed-end funds, REIT, ADR, and foreign companies. In addition, we exclude stocks whose prices were less than five dollars as of the portfolio date and stocks with less than 24 months of past returns data on CRSP. At the end of 4 months after fiscal year end (to ensure firms' annual reports availability), we compute the following variables for each firm: *Investment* (I) is annual capital expenditure (scaled by PPE) most recently reported prior to the portfolio formation date. *Investment Change* (IC) is the most recent *Investment* less *Investment* 1 year before. Accruals (*Accr*) is annual accruals scaled by total assets. We follow Sloan (1996) and measure annual accruals as $(CA - \Delta Cash) - (\Delta CL - \Delta STD - \Delta TP) - DEPEXP$, where ΔCA = change in current assets, $\Delta Cash$ = change in cash and cash equivalents, ΔCL = change in current liabilities, ΔSTD = change in short-term debt, and ΔTP = change in tax payable, and DEPEXP = depreciation and amortization expense. Firm size (*Size*) is market capitalization in million dollars. Firm size and stock price are measured 4 months after fiscal year end. In panel B, Pearson Correlations are shown above the diagonal with Spearman below. All correlation coefficients, except those in italic, are significant at 0.01 levels

a steady capital investment policy. Accruals also have a very small average value, which points to a steady working capital investment.

Panel B shows the correlation coefficients among three capital investment variables, stock price, and firm size. Scaled capital expenditure (I), the change of scaled capital expenditure (IC) and scaled accruals (Accr) are all positively correlated among themselves at the significance level of 0.01. These positive correlations make sense since firms have to invest in both long and short-term assets to grow. In panel B, all three capital investment variables, I, IC and Accr, have insignificant or very low correlations with firm size. Since previous research has shown that firm size is correlated with future stocks returns, this small value of correlation between capital investment variables and firm size is very important to help us to pinpoint the impact of the interaction between past capital investment and past stocks returns on future stocks returns.

3.2 Price momentum

To better understand the impact of capital investment on momentum profits, we first follow Jegadeesh and Titman (1993) to examine the stylized fact about momentum profit.

Specifically, at the beginning of each month, stocks are sorted into quintile portfolios on the basis of their returns over formation period J, which has a value of 3, 6, 9 or 12 months. These quintile portfolios are held for K months, where K has a value of three, six, nine, or twelve. To avoid potential microstructure biases, we impose a 1-week lag between the end of the portfolio formation period (J) and the beginning of the performance measurement period (i.e., holding period), thus each measurement month ends 1 week after the month end. Momentum profits are computed by using an approach similar to the one used in Jegadeesh and Titman (1993). That is, the monthly return for a K-month holding period is based on an equal-weighted average of portfolio returns from strategies implemented in the current month and the previous K − 1 months. For example, the monthly return for a 3-month holding period is based on an equal-weighted average of portfolio returns from this month's strategy, last month's strategy, and the strategy from 2 months ago. This is equivalent to revising the weights of (approximately) one-third of the portfolio each month and carrying over the rest from the previous month. The technique allows us to use simple *t*-statistics for monthly returns. For simplicity of expression, we report the results only for bottom (R1), median (R3) and top (R5) quintile portfolios, where R1 represents the loser portfolio with the lowest return and R5 the winner portfolio with the highest return.

Table 2 summarizes the results for several momentum strategies. Columns 3, 4 and 5 represent the mean return over the portfolio formation period, and the time-series average of the median firm size and median stock price as of the portfolio formation date. Over the portfolio formation period, the stocks in winner portfolio R5 tend to be larger, and have a higher stock price than the stocks in loser portfolio R1. This result is due to the large difference of stock returns between the winner and loser portfolios. For example, for the formation period of 6 months, loser portfolio R1 has lost an average return of 4.6% per month, but the winner portfolio has gained an average return of 7.35%. It is interesting that the stocks in median portfolio R3 are typically larger and have the higher stock price than the stocks in loser portfolio R1 and winner portfolio R5. This result is consistent with the finding in Lee and Swaminathan (2000) and Jegadeesh and Titman (1993).

In Table 2, columns 6–8 are the time-series average of three capital investment variables over the portfolio formation period. Capital investment seems to be negatively correlated with formation-period stock returns, regardless of whether or not capital investment is measured by investment in long-term assets or short-term assets. For example, when capital investment is measured by scaled capital expenditure and the formation period is 6 months, loser portfolio R1 has an average capital investment of 0.136 and lost a monthly average return of 4.6%, whereas winner portfolio R5 has an average capital investment of 0.119 but has gained an average return of 7.35% per month. More interesting, the negative relationship between capital investment and stock returns over the formation period is not monotonic, with the median quintile portfolio R3 having the median average monthly return of 0.9% but the lowest capital investment of 0.107. The negative, non-monotonic relationship between capital investment and stock returns over the formation period is also true of the relationship between capital investment and firm size.

Columns 9 to 12 report equally weighted average monthly stock returns for several momentum strategies. For example, when the formation period and the holding period are both 6 months (J = 6 and K = 6), the momentum profit, the difference between the average returns of winner and loser portfolios R5 and R1, is 0.87% per month.

The results in columns 6–12 also show that capital investment is negatively correlated with holding-period returns. For example, in columns 6 and 9, where capital investment is measured by scaled capital expenditure, and the holding and formation periods are all

Table 2 Characteristics of price momentum portfolios

J	Portfolio	Return	SzRnk	Price	I	IC	Accr	K = 3	K = 6	K = 9	K = 12
3	R1	−3.47	4.73	14.43	0.132	−0.001	−0.021	0.97 (2.88)	0.90 (2.80)	0.89 (2.78)	0.91 (2.87)
	R3	0.43	5.95	21.35	0.108	−0.001	−0.027	1.31 (5.53)	1.30 (5.51)	1.29 (5.46)	1.29 (5.47)
	R5	4.88	5.23	19.48	0.120	−0.003	−0.028	1.45 (5.12)	1.47 (5.18)	1.49 (5.19)	1.45 (5.01)
	R5–R1							0.48 (2.64)	0.55 (3.65)	0.60 (4.77)	0.54 (4.92)
6	R1	−4.60	4.66	13.74	0.136	0.000	−0.020	0.85 (2.46)	0.81 (2.42)	0.81 (2.49)	0.88 (2.75)
	R3	0.90	5.99	21.55	0.107	−0.001	−0.028	1.27 (5.41)	1.27 (5.41)	1.28 (5.43)	1.28 (5.44)
	R5	7.35	5.32	20.59	0.119	−0.003	−0.028	1.68 (5.77)	1.68 (5.71)	1.63 (5.49)	1.53 (5.12)
	R5–R1							0.83 (4.02)	0.87 (4.92)	0.82 (5.31)	0.64 (4.57)
9	R1	−5.38	4.59	13.34	0.138	−0.001	−0.019	0.74 (2.17)	0.75 (2.24)	0.82 (2.51)	0.91 (2.80)
	R3	1.36	6.04	21.78	0.106	−0.001	−0.028	1.25 (5.25)	1.27 (5.33)	1.28 (5.39)	1.28 (5.42)
	R5	9.50	5.37	21.34	0.120	−0.002	−0.028	1.79 (5.95)	1.72 (5.66)	1.60 (5.24)	1.48 (4.83)
	R5–R1							1.05 (5.01)	0.97 (5.20)	0.78 (4.59)	0.58 (3.68)
12	R1	−6.00	4.56	13.04	0.138	−0.003	−0.020	0.72 (2.10)	0.79 (2.34)	0.87 (2.63)	0.95 (2.92)
	R3	1.82	6.03	21.85	0.106	−0.001	−0.028	1.23 (5.20)	1.25 (5.29)	1.26 (5.37)	1.26 (5.39)
	R5	11.44	5.45	21.89	0.121	−0.001	−0.027	1.74 (5.66)	1.62 (5.21)	1.50 (4.81)	1.40 (4.46)
	R5–R1							1.03 (4.86)	0.83 (4.33)	0.64 (3.58)	0.45 (2.70)

This table presents average monthly returns in percentages for price momentum portfolio strategies involving NYSE, AMEX, and NASDAQ stocks for the time period from 1965 to 2004. At the beginning of each month starting in January 1965, all stocks are sorted based on their previous J-month returns and divided into five equal-weighted portfolios. To avoid potential microstructure biases, we compute past returns after imposing a 1-week lag. *R1* represents the *loser* portfolio with the lowest returns, and *R5* represents the *winner* portfolio with the highest returns during the previous J months. K represents future holding periods where K = three, six, nine, or 12 months. Monthly holding period returns are computed similar to Jegadeesh and Titman (1993). That is, the monthly return for a K-month holding period is based on an equal-weighted average of portfolio returns from strategies implemented in the current month and the previous K − 1 months. *Return* refers to the geometric average monthly return in percentages measured over the portfolio formation period, *SzRnk* represents the time-series average of the median size decile of the portfolio (based on NYSE/AMEX/NASDAQ stocks in the sample) on the portfolio formation date, and *I*, *IC*, *Acc* refer to time-series average of the median values. See Table 1 for a description of the sample and for definitions of the three investment variables. For the three investment variables, information of the most recent fiscal year that ends at least 4 months before the portfolio formation date is used. The numbers in parentheses represent simple time-series *t*-statistics for the average monthly returns

3 months, loser portfolio R1 has an average investment of 0.132 but its average monthly return is 0.97%, whereas winner portfolio R5 has an average investment of 0.120 but its return is 1.45% monthly. This finding indicates that high investment stocks tend to have lower future returns. This result is consistent with empirical findings in Titman et al. (2004).

In summary, the empirical findings in Table 2 have reproduced the stylized results for momentum strategies, and characterized the relationship between capital investment and the average stock returns in both the formation and holding periods. Next, we examine the impact of capital investment on momentum strategies.

3.3 Capital investment and momentum strategies

To examine the impact of capital investment on momentum strategies, at the beginning of each month, we first sort all stocks into five momentum portfolios based on past stock returns over period J, which has a value of 3, 6, 9 or 12 months. Then we sort all stocks into five capital investment portfolios independent of the first sort. The intersection of the two independent sorts yields 25 portfolios of interest. These portfolios are held for K months where K = 3, 6, 9, or 12.

Table 3 summarizes the results about the impact of capital investment on momentum returns. To simplify exposition, we only present the results for the momentum strategy with J = K = 6. Results for other strategies are qualitatively similar and thus omitted. As in Table 2, R1, R3 and R5 represent the loser, the median and the winner portfolios, respectively. V1 represents the portfolio with the smallest capital investment and V5 the portfolio with the largest capital investment. (R5–R1, V3–V1) is the momentum return difference between the low capital investment and the medium capital investment portfolios. Similarly (R5–R1, V5–V3), indicates the difference of the momentum returns between the medium and high capital investment portfolios.

Panels A, B and C of Table 3 report the interaction between capital investment and momentum strategies when capital investment is measured by scaled capital expenditure, I, the change of scaled capital expenditure, IC, and accruals, Accr. In the following, we first discuss the impact of capital investment on momentum profit when capital investment is measured by scaled capital expenditure.

As shown in Panel A of Table 3, several interesting results appear. First, momentum portfolios with large capital investment tend to yield a larger momentum profit. Specifically, momentum profit tends to be similar when scaled capital expenditure is from small to median, and then increases monotonically when scaled capital expenditure changes from median to large. Momentum profit (R5–R1) decreases slightly from a monthly return of 0.57–0.55% and then increases to 0.66% when capital investment increases from V1 to V3. Nevertheless, this momentum profit change is not significant, as shown in the *t*-statistics for the sub-portfolio (V3–V1, R5–R1), which is (V3, R5–R1) − (V1, R5–R1), i.e., the difference of the momentum profits between V3 and V1. When capital investment increases from V3 to V5, the monthly momentum profit increases monotonically from 0.66 to 1.31%. This increase of 0.65%, as shown in (V5–V3, R5–R1), is significant (t = 5.54). Therefore, when capital investment is small, increasing capital investment doesn't significantly improve momentum profit. However, when capital investment starts at the median level, increasing capital investment can significantly increase momentum profit.

Table 3 Monthly returns for portfolios based on price momentum and capital investments

J = K = 6	Monthly returns								Average number of stocks				
Portfolio	V1	V2	V3	V4	V5	V3–V1	V5–V3	V5–V1	V1	V2	V3	V4	V5
Panel A: capital investment (V = capital expenditure, I)													
R1	1.06 (3.59)	1.11 (3.72)	0.97 (3.06)	0.80 (2.34)	0.38 (0.94)	−0.08 (−0.82)	−0.60 (−4.44)	−0.68 (−4.07)	169	172	191	218	253
R3	1.38 (6.29)	1.36 (6.07)	1.29 (5.36)	1.15 (4.43)	1.02 (3.29)	−0.10 (−1.41)	−0.27 (−2.55)	−0.37 (−2.62)	271	288	283	261	225
R5	1.64 (5.80)	1.66 (5.96)	1.63 (5.54)	1.70 (5.53)	1.69 (4.67)	0.00 (−0.03)	0.05 (0.47)	0.05 (0.34)	199	181	185	196	208
R5–R1	0.57 (3.42)	0.55 (3.40)	0.66 (3.76)	0.90 (5.09)	1.31 (6.74)	0.08 (0.74)	0.65 (5.51)	0.74 (5.54)					
Panel B: capital investment (V = change in capital expenditure, IC)													
R1	0.76 (2.07)	0.97 (2.99)	1.00 (3.31)	0.94 (2.99)	0.50 (1.34)	0.24 (1.85)	−0.50 (−4.22)	−0.27 (−3.38)	227	190	171	192	242
R3	1.36 (4.87)	1.22 (5.14)	1.30 (5.88)	1.28 (5.46)	1.11 (4.08)	−0.06 (−0.53)	−0.19 (−1.96)	−0.24 (−3.76)	246	282	289	279	249
R5	1.85 (5.45)	1.67 (5.77)	1.63 (6.13)	1.63 (5.78)	1.57 (4.75)	−0.22 (−1.74)	−0.06 (−0.54)	−0.28 (−3.26)	228	191	176	184	205
R5–R1	1.09 (6.11)	0.70 (3.99)	0.63 (3.79)	0.69 (3.86)	1.07 (5.81)	−0.45 (−3.95)	0.44 (3.92)	−0.01 (−0.14)					
Panel C: capital investment (V = Accrual, Accr)													
R1	0.94 (2.43)	1.16 (3.20)	0.93 (2.61)	0.74 (2.01)	0.36 (0.89)	−0.01 (−0.05)	−0.58 (−4.94)	−0.58 (−5.16)	205	191	193	217	259
R3	1.46 (5.28)	1.38 (5.58)	1.29 (5.43)	1.20 (4.56)	0.95 (3.05)	−0.17 (−2.15)	−0.34 (−3.02)	−0.51 (−6.01)	260	290	297	282	248
R5	1.84 (5.37)	1.78 (5.80)	1.59 (5.33)	1.66 (4.98)	1.48 (3.95)	−0.25 (−2.47)	−0.11 (−0.87)	−0.36 (−3.33)	242	200	183	194	206
R5–R1	0.90 (4.33)	0.62 (2.80)	0.66 (2.95)	0.92 (4.32)	1.12 (6.00)	−0.24 (−1.84)	0.47 (3.41)	0.23 (1.60)					

This table presents average monthly returns from portfolio strategies formed by independent two-way sorts (*five by five*) on past returns and recent annual capital expenditure scaled by PPE (I), or its change from 1 year ago (IC), or accruals (Accr) for the 1965 to 2004 time period. To ensure a meaningful sample size, the accruals variable before 1971 is omitted. At the beginning of each month all available stocks on NYSE/AMEX/NASDAQ are sorted based on past 6-month returns (J = 6) and divided into five portfolios. *R1* represents the *loser* portfolio, and *R5* represents the *winner* portfolio. To avoid potential microstructure biases, we compute past returns after imposing a 1-week lag. The stocks are also independently sorted into five V portfolios (V1 the lowest and V5 the highest) based on recent annual capital expenditure (scaled by PPE), annual changes in capital expenditure, or accruals. The stocks at the intersection of the two sorts are grouped together to form portfolios based on past returns and past investments. Table values are the average monthly return for each portfolio over the next 6 months (K = 6). The portfolio returns for each month is computed as an equal-weighted average of returns from strategies initiated at the end of each of the past J months. The numbers in parentheses are simple *t*-statistics for monthly returns. The five columns on the right report the average number of firms per month in each sub-portfolio. See Table 1 for measurement of I, IC, and Accr. For these three investment variables, information of the most recent fiscal year that ends at least 4 months before the portfolio formation date is used

Second, the losing portfolio with the largest capital investment (R1V5) has the smallest return of 0.38%. This finding is not surprising since large capital investment tends to have a small future stock return, a result discussed in Table 2. The impact of capital investment on the returns of winning portfolios, however, seems insignificant.

Finally, capital investment can help significantly improve momentum profit. As shown in Table 2, when capital investment is not considered, for the momentum strategy with the formation period of 6 months and the holding period of 6 months, the momentum profit is 0.87% per month. However, with capital investment considered, for the same momentum strategy, if we form a zero-cost portfolio by buying the winning portfolio with the largest capital investment (R5V5) and shorting the losing portfolio with the largest investment (R1V5), the monthly return for this zero cost portfolio is 1.31%, a 51% increase from the momentum profit without capital investment.

Because these sorts are conducted independently, a possible concern is that the results are based on insufficient number of firms in some extreme cells. The right-hand-side columns address this issue. These table values represent the average number of firms per month in each sub-portfolio. For example, a strategy of buying low capital investment winners and shorting low capital investment losers would involve an average of 169 firms on the short side and 199 firms on the long side. A similar high investment momentum strategy would involve 253 firms on the short side and 208 firms on the long side. Overall, these seem to be good portfolio sizes, suggesting that our results are not driven by a few unusual firms.

In Panels B of Table 3, where capital investment is measured by the change of scaled capital expenditure (IC), several interesting results also appear. First, unlike in Panel A, the impact of capital investment on momentum profit exhibits a clearer "U" curve on the portfolios sorted on capital investment. That is, from the smallest investment portfolio to the median one, momentum effect monotonically decreases. From the median investment portfolio to the largest one, momentum effect monotonically increases. When capital investment increases from V1 to V3, the monthly momentum profit decreases from 1.09 to 0.63%. When capital investment increases from V3 to V5, the monthly momentum profit increases from 0.63 to 1.07%. A close look at the *t*-statistics for the difference of the momentum profits between V1 and V3 (V3–V1, R5–R1) and the difference of the momentum profits between V5 and V3 (V5–V3, R5–R1) shows that these two momentum profit differences are all significant. However, the momentum profit difference between V1 and V5 (V5–V1, R5–R1) is not significant. This finding implies that the change of capital expenditure in either direction is likely to equally affect momentum profit.

Second, as in Panel A, the loser portfolio with the largest capital investment (R1V5) still has the smallest monthly return of 0.50%. However, unlike in Panel A, the winning portfolio with the smallest capital investment (R5V1) has the largest return.

Finally, as in Panel A, capital investment can significantly improve momentum profit. If we form a zero-cost portfolio by buying the winning portfolio with the smallest capital investment (R5V1) and shorting the largest capital investment losing portfolio (R1V5), the monthly return for this zero cost portfolio is 1.35%, a 55% increase from the monthly momentum profit of 0.87%, as presented in Table 2.

The results in Panel C of Table 3 are similar to those in Panel B. In summary, the empirical findings in Table 3 show that capital investment has a significant impact on momentum profit. In general, stocks with large capital investment tend to have a stronger momentum effect. Consideration of capital investment in a trading strategy can significantly improve momentum profit.

3.4 Robustness checks

Table 4 summarizes the results about the robustness check of our empirical finding when we divide our sample period into four sub-periods: 1965–1974, 1975–1984, 1985–1994, and 1995–2004. For simplicity of exposition, we only report the results for the momentum strategy with both the formation and holding periods of 6 months (J = K = 6). As shown there, in all four sub-periods, the empirical results are very close to the ones discussed in Table 3. That is, the stocks with large capital investment tend to yield a larger momentum profit return, and the impact of capital investment on momentum profit tends to be a "U" curve when capital investment is represented by the change of capital expenditure or accruals. When capital investment is measured by scaled capital expenditure, momentum profit increases monotonically and significantly from median to large. When capital expenditure is from small to median, momentum profit tends to increase in two sub-periods: 1965–1974 and 1985–1994, and decrease in the other two sub-periods, but this increase or decrease is not significant, as shown in the *t*-statistics for the momentum profit difference between V3 and V1. Therefore, momentum effect is similar when scaled capital expenditure is from small to median, and increases monotonically and significantly when capital expenditure increases from median to large.

So far our empirical results are based on independent sorting of the stocks into five price momentum portfolios and five capital investment portfolios (5 × 5). To make sure that our empirical findings are robust to this sorting, Table 5 reports the empirical results for sorting the stocks into ten momentum portfolios and three capital investment portfolios (10 × 3). Clearly, as shown there, our previous empirical findings still hold.

3.5 Risk adjustment

To understand whether or not capital investment-based momentum strategies can be explained by risk factors, we use the Fama–French three factor model to run time-series regression for monthly portfolio returns (Fama and French 1992, 1993). Specifically, we run the following regression to obtain the risk-adjusted return for each portfolio.

$$r_i - r_f = a_i + b_i(r_m - r_f) + s_i\text{SMB} + h_i\text{HML} + e_i$$

where r_i is the monthly return for portfolio *i*, r_f is the 1-month T-Bill return from Ibbotson and Associates, Inc., r_m is the return on the NYSE/AMEX/NASDAQ value-weighted market index, SMB is the Fama–French small firm factor, and HML is the Fama–French value factor; a_i is the intercept of the portfolio, b_i, s_i and h_i are the loadings on the market, small firm and value factors, respectively. The data for three factors are from Professor Ken French's website.[2]

Table 6 reports the intercepts of the three factor model for 25 investment-return portfolios for each capital investment proxy. The intercept of the regression can be regarded as the risk-adjusted return of the portfolio with respect to the Fama–French three factor model.

In Panel A, the loser portfolio with the largest capital investment (R1V5) has the lowest risk adjusted return, and the winner portfolio with the largest capital investment (R5V5) has the highest risk adjusted return. However, in Panels B and C, in which capital investment is represented by the change of scaled capital expenditure and accruals,

[2] The web-address is: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Table 4 Monthly momentum returns on portfolios based on price momentum and capital investments: sub-period results

J = K = 6	V1	V2	V3	V4	V5	V3–V1	V5–V3	V5–V1
Panel A: capital investment (V = capital expenditure, I)								
1965–1974	0.30 (0.85)	0.51 (1.38)	0.64 (1.76)	1.17 (2.94)	1.51 (3.70)	0.31 (1.41)	0.88 (3.84)	1.25 (5.31)
1975–1984	0.59 (2.13)	0.47 (1.81)	0.49 (1.65)	0.66 (2.18)	1.05 (3.11)	−0.10 (−0.45)	0.56 (2.34)	0.46 (1.83)
1985–1994	0.50 (1.81)	0.51 (2.35)	0.68 (3.16)	0.89 (4.36)	1.36 (6.22)	0.18 (0.81)	0.68 (3.07)	0.87 (3.25)
1995–2004	0.89 (2.13)	0.72 (1.71)	0.83 (1.73)	0.90 (1.94)	1.32 (2.50)	−0.06 (−0.26)	0.49 (1.94)	0.44 (1.41)
Panel B: capital investment (V = change in capital expenditure, IC)								
1965–1974	1.12 (2.90)	0.80 (2.01)	0.79 (2.13)	0.70 (1.82)	1.02 (2.69)	−0.33 (−1.47)	0.23 (0.95)	−0.10 (−0.44)
1975–1984	0.94 (3.36)	0.56 (1.89)	0.42 (1.34)	0.66 (2.20)	0.95 (2.95)	−0.52 (−2.63)	0.53 (2.44)	0.01 (0.06)
1985–1994	1.09 (4.81)	0.74 (3.40)	0.46 (1.99)	0.53 (2.32)	1.16 (5.90)	−0.63 (−2.70)	0.70 (3.50)	0.07 (0.39)
1995–2004	1.19 (2.49)	0.70 (1.55)	0.86 (2.16)	0.87 (1.83)	1.15 (2.26)	−0.33 (−1.27)	0.29 (1.22)	−0.04 (−0.18)
Panel C: capital investment (V = Accrual, Accr)								
1975–1984	0.69 (2.39)	0.63 (1.83)	0.78 (2.27)	0.67 (2.27)	1.01 (3.56)	0.08 (0.34)	0.23 (0.94)	0.31 (1.30)
1985–1994	1.05 (4.75)	0.54 (2.41)	0.16 (0.65)	0.68 (3.09)	1.18 (5.92)	−0.89 (−4.29)	1.03 (4.72)	0.14 (0.67)
1995–2004	1.10 (2.05)	0.71 (1.24)	0.85 (1.46)	1.38 (2.44)	1.08 (2.25)	−0.25 (−0.92)	0.23 (0.82)	−0.02 (−0.07)

This table presents sub-period results of monthly momentum returns from portfolio strategies formed by independent two-way sorts (*five by five*) on past returns and recent annual capital expenditure scaled by PPE (I), or its change from 1 year ago (IC), or accruals (Accr) for the 1965 to 2004 time period. Formation periods and holding periods are both 6 months (J = K = 6). To ensure a meaningful sample size, the accruals variable before 1971 is omitted. The momentum-investment strategies are described in table III. For sample, variable definitions, and portfolio rebalancing strategies, see Table 3

Table 5 Monthly momentum returns for portfolios based on price momentum and capital investments (10 by 3 sorts)

J	K = 6						K = 12					
	V1	V2	V3	V2–V1	V3–V2	V3–V1	V1	V2	V3	V2–V1	V3–V2	V3–V1
Panel A: capital investment (V = capital expenditure, I)												
3	0.53 (3.08)	0.65 (3.58)	1.13 (5.63)	0.12 (1.14)	0.48 (4.71)	0.60 (5.07)	0.47 (3.83)	0.63 (4.75)	0.97 (6.59)	0.16 (1.99)	0.34 (4.19)	0.50 (5.16)
6	0.86 (4.22)	0.95 (4.40)	1.56 (6.71)	0.08 (0.66)	0.61 (5.07)	0.70 (4.84)	0.57 (3.56)	0.65 (3.82)	1.12 (6.04)	0.08 (0.82)	0.47 (4.64)	0.55 (4.34)
9	0.98 (4.51)	0.98 (4.25)	1.60 (6.60)	0.00 (−0.02)	0.62 (4.88)	0.62 (3.89)	0.45 (2.51)	0.53 (2.77)	0.95 (4.60)	0.08 (0.70)	0.42 (3.73)	0.50 (3.50)
12	0.79 (3.33)	0.79 (3.28)	1.34 (5.43)	0.00 (−0.01)	0.55 (4.08)	0.55 (3.31)	0.31 (1.54)	0.38 (1.81)	0.72 (3.37)	0.07 (0.61)	0.34 (2.91)	0.41 (2.75)
Panel B: capital investment (V = change in capital expenditure, IC)												
3	0.87 (4.74)	0.58 (3.18)	0.94 (4.68)	−0.30 (−2.97)	0.36 (3.70)	0.07 (0.72)	0.75 (5.64)	0.59 (4.45)	0.79 (5.43)	−0.17 (−2.18)	0.20 (2.70)	0.04 (0.54)
6	1.30 (6.01)	0.93 (4.33)	1.30 (5.67)	−0.37 (−2.96)	0.37 (2.98)	0.01 (0.05)	0.89 (5.20)	0.70 (4.06)	0.87 (4.82)	−0.18 (−1.82)	0.17 (1.66)	−0.01 (−0.14)
9	1.35 (5.97)	1.01 (4.42)	1.34 (5.68)	−0.34 (−2.47)	0.33 (2.46)	−0.01 (−0.06)	0.77 (4.03)	0.59 (3.08)	0.70 (3.53)	−0.18 (−1.58)	0.11 (0.99)	−0.07 (−0.65)
12	1.10 (4.63)	0.91 (3.76)	1.10 (4.53)	−0.19 (−1.37)	0.20 (1.37)	0.01 (0.05)	0.57 (2.79)	0.46 (2.23)	0.51 (2.43)	−0.11 (−0.90)	0.05 (0.41)	−0.06 (−0.56)
Panel C: capital investment (V = Accrual, Accr)												
3	0.70 (3.22)	0.65 (3.02)	1.05 (5.05)	−0.04 (−0.39)	0.40 (3.74)	0.36 (2.89)	0.66 (4.29)	0.66 (4.23)	0.86 (5.73)	0.00 (0.00)	0.19 (2.06)	0.19 (2.40)
6	1.15 (4.51)	1.06 (4.26)	1.35 (5.95)	−0.09 (−0.67)	0.30 (2.04)	0.21 (1.57)	0.80 (4.05)	0.72 (3.61)	0.88 (4.86)	−0.08 (−0.76)	0.16 (1.37)	0.08 (0.77)
9	1.28 (4.76)	1.19 (4.72)	1.31 (5.64)	−0.09 (−0.61)	0.11 (0.77)	0.03 (0.19)	0.70 (3.14)	0.62 (2.83)	0.71 (3.56)	−0.08 (−0.64)	0.09 (0.70)	0.01 (0.09)
12	1.04 (3.80)	0.90 (3.35)	1.06 (4.49)	−0.14 (−0.93)	0.16 (1.07)	0.02 (0.15)	0.48 (2.11)	0.44 (1.88)	0.51 (2.44)	−0.04 (−0.31)	0.07 (0.52)	0.03 (0.27)

This table presents average monthly returns from portfolio strategies (R10–R1) formed by independent two-way sorts (*ten by three*) on past returns and recent annual capital expenditure scaled by PPE (I), its change from 1 year ago (IC), or accruals (Accr) for the 1965 to 2004 time period. To ensure a meaningful sample size, the accruals variable before 1971 is omitted. At the beginning of each month all available stocks on NYSE/AMEX/NASDAQ are sorted based on past J month returns and divided into ten portfolios. *R1(R10)* represents the *loser (winner)* portfolio. To avoid potential microstructure biases, we compute past returns after imposing a 1-week lag. The stocks are also independently sorted into three V portfolios (V1 the lowest and V3 the highest) based on recent annual capital expenditure (scaled by PPE), annual changes in capital expenditure, or accruals. The portfolio returns for each month is computed as an equal-weighted average of returns from strategies initiated at the end of each of the past J months. Table values are the average monthly momentum return over the next K months. The numbers in parentheses are simple *t*-statistics for monthly returns. See Table 1 for measurement of I, IC, and Accr. For these three investment variables, information of the most recent fiscal year that ends at least 4 months before the portfolio formation date is used

Table 6 Three-factor regressions of monthly excess returns on price momentum-investment portfolios

Portfolio	V1	V3	V5	V3–V1	V5–V3	V5–V1
Panel A: capital investment (V = I)						
R1	0.38 (1.88)	0.33 (1.48)	−0.25 (−0.91)	−0.04 (−0.48)	−0.58 (−5.00)	−0.63 (−4.46)
R3	0.74 (5.40)	0.69 (4.62)	0.42 (2.14)	−0.05 (−0.77)	−0.27 (−3.14)	−0.32 (−2.89)
R5	1.06 (5.76)	1.13 (5.68)	1.21 (4.97)	0.06 (0.66)	0.09 (0.85)	0.15 (1.09)
R5–R1	0.68 (4.01)	0.80 (4.51)	1.47 (7.49)	0.11 (1.00)	0.67 (5.54)	0.79 (5.85)
Panel B: change of capital expenditure (V = IC)						
R1	0.12 (0.49)	0.35 (1.65)	−0.16 (−0.64)	0.22 (2.00)	−0.51 (−4.94)	−0.29 (−3.54)
R3	0.72 (4.23)	0.71 (5.01)	0.50 (2.97)	−0.01 (−0.10)	−0.21 (−2.74)	−0.22 (−3.33)
R5	1.33 (5.84)	1.08 (6.21)	1.07 (4.93)	−0.25 (−2.23)	−0.02 (−0.16)	−0.27 (−3.02)
R5–R1	1.21 (6.69)	0.74 (4.34)	1.23 (6.63)	−0.47 (−4.00)	0.49 (4.28)	0.02 (0.19)
Panel C: accruals (V = Accr)						
R1	0.32 (1.18)	0.32 (1.22)	−0.32 (−1.16)	−0.00 (−0.02)	−0.64 (−5.85)	−0.64 (−5.56)
R3	0.84 (4.77)	0.71 (4.56)	0.35 (1.74)	−0.13 (−1.82)	−0.36 (−4.09)	−0.49 (−6.04)
R5	1.34 (5.78)	1.12 (5.54)	0.99 (4.11)	−0.22 (−2.27)	−0.12 (−1.15)	−0.35 (−3.35)
R5–R1	1.02 (4.81)	0.80 (3.54)	1.31 (7.00)	−0.22 (−1.62)	0.52 (3.68)	0.30 (2.05)

This table reports the intercepts of the Fama–French three-factor regression model for monthly excess returns on price momentum and capital investments portfolios (*five by five*) for J = 6, K = 6 portfolio strategies. J represents the months before the portfolio formation date, and K represents holding period months after the portfolio formation date. *R5 (R1)* represents the winner (loser) portfolio. V5 represents the highest investment (investment change, or accrual) portfolio. V1 represents the lowest investment (investment change, or accrual) portfolio. The three investment variables are defined in Table 1. The three-factor regression is as follows: $r_i - r_f = a_i + b_i(r_m - r_f) + s_i\,\text{SMB} + h_i\,\text{HML} + e_i$ where r_m is the return on the NYSEM/AMEX/NASDAQ value-weighted market index, r_f is 1-month T-Bill return from Ibbotson and Associates, Inc., SMB is the small firm factor, and HML is the value factor. The factor values are taken from Ken French's website. The numbers within parentheses represent White heteroskedasticity-corrected *t*-statistics. There are 480 months from January 1965 to December 2004 (406 months for accruals)

respectively, the loser portfolio with the largest capital investment (R1V5) has the lowest risk adjusted return. On the other hand, the winner portfolio with the smallest capital investment (R5V1) has the highest risk adjusted return, a result same as in Table 3.

In addition, when we use the risk-adjusted return in our analysis, capital investment seems to increase momentum profit more. For example, in Panel A of Table 6, where capital investment is denoted by scaled capital expenditure, the trading strategy of selling the loser portfolio with the largest investment and buying the winner portfolio with the largest investment achieves a monthly profit of 1.47%, an increase of 69% over the monthly momentum return of 0.87% in Table 2. As discussed in Table A of Table 3, if we use the return without risk adjustment, capital investment can improve the monthly momentum return by 51% for the same momentum strategy.

In summary, large capital investment stocks tend to have a stronger momentum effect even for the risk-adjusted return with respect to the Fama–French three factor model, as shown in Table 6. As discussed before, momentum effect tends to be similar when capital expenditure is from small to median, and then increases monotonically when capital expenditure capital increases from median to large. On the other hand, the impact of capital investment on momentum profits is also a "U" curve on the portfolios sorted on the change of scaled capital expenditure or accruals.

3.6 Momentum profits in various subsamples

Momentum may be affected by firms' characteristic variables other than capital investment. To address this concern, we assess the robustness of momentum profitability across capital investment dimension based on $3 \times 3 \times 3$ portfolios sorted independently on stock returns, capital investment, and various firm characteristics such as firm size, analyst coverage, firm age, leverage, and credit rating.[3]

Panel A of Table 7 presents results for sorts by capital investment (measured as scaled capital expenditure, I) and firm size. Clearly, momentum returns increase with capital investment across all size groups. For instance, for the small (large) firms, momentum returns increase monotonically from 0.59% (0.02%) to 1.05% (0.76%) per month moving from low investment to high investment firms. The increase is significant with a *t*-stat of 4.11(5.24). There is some interaction between firm size and capital investment as the highest momentum return exists in the small, high investment firms (1.05%) and the lowest exists in the large, low investment firms (0.02%). The effect of capital investment on momentum is incremental to that of firm size.

Panel B to E show similar results for analyst coverage, firm age, leverage, and credit rating. Momentum returns seem stronger in firms with lower analyst coverage, younger, or with worse credit ratings. Leverage, on the other hand, does not seem to affect momentum returns. Once again, momentum returns increase with capital investment across each subgroups. The differential impact of capital investment on momentum profits is comparable to that of firm age and that of analyst coverage but larger than that of leverage or that of credit rating.

Panel F to panel J present subsample results where capital investment is measured by the change of scaled capital expenditure (IC). Similar to results in Panel B of Table 3, momentum returns first decrease then increase with capital investment across each size, analyst coverage, age, leverage, and credit rating group, i.e., the impact of capital investment on momentum profit exhibits a "U" curve. For instance, for the small (large) firms, momentum returns decrease from 0.90% (0.46%) to 0.64% (0.20%) per month moving from low investment to medium investment, and then increase to 0.89% (0.48%) to high investment firms. Panel K to panel O present subsample results where capital investment is measured by the accruals (ACCR). Once again, the impact generally exhibits a "U" curve across each subgroup of alternative firm characteristics.

In summary, the evidence strongly suggests that capital investment has on momentum a strong impact that cannot be explained away by firm characteristic variables such as firm size and analyst coverage.

4 Intuitions behind the empirical findings

In the previous section, we have discussed the empirical findings on the impact of capital investment on momentum strategies. In this section, based on several behavioral finance theories, we present a simple explanation to help understand the economic intuition behind our empirical results.

When capital investment is measured by scaled capital expenditure, in general, firms with large capital investment are more likely to take new projects than firms with small or median investment. New projects tend to result in more uncertainty for future earnings and

[3] We would like to thank one referee for suggesting this analysis.

Table 7 Monthly returns for portfolios based on price momentum, capital investments, and alternative firm characteristics

	V1	V2	V3	V2–V1	V3–V2	V3–V1
Panel A: independent sort by capital investment (V = capital expenditure, I) and firm size						
Small	0.59 (4.80)	0.84 (6.18)	1.05 (7.52)	0.26 (2.17)	0.21 (1.83)	0.47 (4.11)
Medium	0.34 (2.34)	0.36 (2.46)	0.94 (5.46)	0.02 (0.22)	0.57 (5.30)	0.60 (5.00)
Big	0.02 (0.12)	0.20 (1.21)	0.76 (3.89)	0.18 (1.72)	0.56 (5.32)	0.74 (5.24)
Panel B: independent sort by capital investment (V = capital expenditure, I) and number of analysts						
Low	0.57 (3.05)	0.72 (3.36)	1.04 (4.63)	0.16 (0.99)	0.32 (2.05)	0.47 (2.76)
Medium	0.16 (0.75)	0.36 (1.60)	0.68 (2.72)	0.20 (1.46)	0.32 (1.97)	0.52 (3.08)
High	−0.05 (−0.18)	0.28 (0.97)	0.57 (1.90)	0.32 (1.93)	0.29 (1.50)	0.61 (2.72)
Panel C: independent sort by capital investment (V = capital expenditure, I) and firm age						
Young	0.60 (4.08)	0.71 (4.49)	1.11 (6.91)	0.11 (0.92)	0.39 (3.55)	0.51 (4.14)
Medium	0.48 (3.58)	0.44 (3.21)	0.85 (5.22)	−0.04 (−0.36)	0.41 (4.23)	0.37 (3.20)
Old	0.03 (0.21)	0.25 (1.81)	0.54 (3.13)	0.22 (2.43)	0.30 (2.56)	0.51 (3.73)
Panel D: independent sort by capital investment (V = capital expenditure, I) and leverage						
Low	0.38 (2.36)	0.40 (2.64)	0.85 (5.14)	0.02 (0.15)	0.45 (4.27)	0.47 (3.69)
Medium	0.31 (2.33)	0.38 (2.69)	1.03 (6.33)	0.07 (0.76)	0.65 (6.16)	0.72 (6.03)
High	0.34 (2.48)	0.48 (3.26)	0.96 (5.75)	0.14 (1.31)	0.48 (3.94)	0.62 (4.41)
Panel E: independent sort by capital investment (V = capital expenditure, I) and credit rating						
Good	−0.22 (−1.47)	−0.01 (−0.09)	0.44 (2.25)	0.20 (1.38)	0.42 (2.68)	0.66 (3.60)
Medium	−0.10 (−0.52)	0.25 (1.47)	0.72 (3.88)	0.29 (1.83)	0.48 (3.05)	0.81 (4.36)
Bad	0.30 (1.81)	0.53 (3.08)	0.92 (4.65)	0.22 (1.36)	0.35 (1.98)	0.58 (3.07)
Panel F: independent sort by capital investment (V = change in capital expenditure, IC) and firm size						
Small	0.90 (6.79)	0.64 (5.18)	0.89 (6.68)	−0.26 (−2.31)	0.25 (2.31)	−0.01 (−0.07)
Medium	0.60 (3.80)	0.48 (3.24)	0.68 (4.10)	−0.12 (−1.14)	0.19 (1.80)	0.08 (0.79)
Big	0.46 (2.42)	0.20 (1.22)	0.48 (2.62)	−0.27 (−2.63)	0.28 (2.76)	0.03 (0.30)
Panel G: independent sort by capital investment (V = change in capital expenditure, IC) and number of analysts						
Low	0.93 (4.34)	0.55 (2.91)	0.83 (3.69)	−0.37 (−2.13)	0.28 (1.78)	−0.10 (−0.58)
Medium	0.53 (2.34)	0.20 (0.88)	0.44 (1.86)	−0.33 (−2.07)	0.24 (1.62)	−0.09 (−0.60)
High	0.33 (1.12)	0.13 (0.52)	0.50 (1.65)	−0.20 (−1.12)	0.37 (2.10)	0.17 (1.01)
Panel H: independent sort by capital investment (V = change in capital expenditure, IC) and firm age						
Young	0.92 (6.09)	0.70 (4.38)	0.96 (5.95)	−0.22 (−2.01)	0.27 (2.37)	0.05 (0.49)
Medium	0.61 (4.18)	0.49 (3.54)	0.67 (4.66)	−0.12 (−1.21)	0.18 (1.86)	0.06 (0.63)
Old	0.25 (1.67)	0.14 (0.99)	0.36 (2.47)	−0.12 (−1.31)	0.24 (2.46)	0.11 (1.14)
Panel I: independent sort by capital investment (V = change in capital expenditure, IC) and leverage						
Low	0.58 (3.73)	0.42 (2.55)	0.72 (4.43)	−0.16 (−1.52)	0.30 (2.91)	0.15 (1.51)
Medium	0.61 (3.99)	0.39 (2.90)	0.78 (5.32)	−0.21 (−2.10)	0.39 (3.97)	0.18 (1.79)
High	0.75 (5.32)	0.33 (2.34)	0.60 (3.96)	−0.41 (−3.69)	0.26 (2.24)	−0.15 (−1.26)
Panel J: independent sort by capital investment (V = change in capital expenditure, IC) and credit rating						
Good	0.10 (0.61)	−0.01 (−0.05)	0.16 (0.93)	−0.17 (−1.20)	0.22 (1.49)	0.08 (0.52)
Medium	0.24 (1.29)	0.14 (0.81)	0.47 (2.67)	−0.07 (−0.43)	0.30 (1.96)	0.23 (1.54)
Bad	0.55 (3.07)	0.55 (3.11)	0.66 (3.72)	−0.02 (−0.14)	0.11 (0.68)	0.06 (0.37)
Panel K: independent sort by capital investment (V = Accrual, Accr) and firm size						
Small	0.87 (6.06)	0.82 (5.75)	0.96 (7.01)	−0.05 (−0.43)	0.14 (1.26)	0.09 (0.79)

Table 7 continued

	V1	V2	V3	V2–V1	V3–V2	V3–V1
Medium	0.49 (2.73)	0.36 (2.05)	0.85 (5.05)	−0.13 (−1.13)	0.49 (4.46)	0.36 (3.10)
Big	0.27 (1.26)	0.31 (1.52)	0.53 (2.49)	0.04 (0.37)	0.22 (1.92)	0.26 (2.07)
Panel L: Independent Sort by Capital Investment (V = Accrual, Accr) and Number of Analysts						
Low	0.79 (3.68)	0.49 (2.33)	1.02 (4.73)	−0.30 (−1.87)	0.52 (3.45)	0.23 (1.28)
Medium	0.33 (1.27)	0.27 (1.13)	0.63 (2.79)	−0.05 (−0.36)	0.36 (2.12)	0.31 (1.80)
High	0.25 (0.87)	0.23 (0.76)	0.48 (1.53)	−0.02 (−0.13)	0.25 (1.29)	0.24 (1.44)
Panel M: independent sort by capital investment (V = Accrual, Accr) and firm age						
Young	0.76 (3.93)	0.88 (5.08)	1.02 (6.28)	0.13 (1.11)	0.14 (1.27)	0.26 (2.01)
Medium	0.59 (3.66)	0.44 (2.66)	0.77 (5.12)	−0.15 (−1.40)	0.33 (3.09)	0.18 (1.48)
Old	0.23 (1.42)	0.13 (0.82)	0.38 (2.26)	−0.10 (−0.89)	0.25 (2.04)	0.15 (1.26)
Panel N: independent sort by capital investment (V = Accrual, Accr) and leverage						
Low	0.51 (2.65)	0.45 (2.51)	0.81 (4.84)	−0.07 (−0.53)	0.36 (3.47)	0.29 (2.29)
Medium	0.46 (2.83)	0.43 (2.84)	0.71 (4.66)	−0.03 (−0.31)	0.27 (2.58)	0.24 (2.06)
High	0.61 (3.85)	0.40 (2.38)	0.72 (4.79)	−0.21 (−1.72)	0.33 (2.56)	0.11 (0.88)
Panel O: independent sort by capital investment (V = Accrual, Accr) and credit rating						
Good	0.19 (1.04)	−0.11 (−0.69)	0.15 (0.79)	−0.31 (−2.00)	0.26 (1.65)	−0.05 (−0.30)
Medium	0.29 (1.55)	0.11 (0.61)	0.56 (2.90)	−0.18 (−1.07)	0.45 (2.65)	0.27 (1.52)
Bad	0.68 (3.20)	0.58 (2.79)	0.66 (3.34)	−0.08 (−0.39)	0.08 (0.42)	0.01 (0.05)

This table presents average monthly returns from portfolio strategies formed by independent three-way sorts (*three by three by three*) on past returns, capital investments (recent annual capital expenditure scaled by PPE (I), its change from 1 year ago (IC), or accruals (Accr)), and alternative firm characteristics (firm size, number of analysts, firm age, leverage, and credit rating) for the 1965 to 2004 time period. To ensure a meaningful sample size, the accruals variable before 1971 is omitted; the sample with number of analysts following a firm starts in 1984. At the beginning of each month all available stocks on NYSE/AMEX/NASDAQ are sorted based on past 6 month returns (J = 6) and divided into three portfolios. *R1* represents the *loser* portfolio, and *R3* represents the *winner* portfolio. To avoid potential microstructure biases, we compute past returns after imposing a 1-week lag. The stocks are also independently sorted on firm characteristics and capital investments (V1 denotes low investment and V3 high investment). The stocks at the intersection of the three-way sorts are grouped together to form portfolios. The table shows, for each group, the average monthly returns of the momentum strategy, which involves buying the winner portfolio R3 and selling the loser portfolio R1 and holding the position for 6 months (K = 6). The numbers in parentheses are simple *t*-statistics for monthly returns. Firm size is market capitalization in million dollars. Analyst coverage is computed as the average number of analysts following a firm in a year. Firm age represents the number of months since a firm's IPO. Leverage is the sum of short-term and long-term debt over total assets. Credit rating is S&P Long-Term Domestic Issuer Credit Rating. See Table 1 for measurement of I, IC, and Accr. For these three investment variables, information of the most recent fiscal year that ends at least 4 months before the portfolio formation date is used

cash flows. Thus, the volatility of future earnings and cash flows can be similar when capital investment is from small to median, and then increases when capital investment increases from median to large. Since stock value will become more difficult or less accurate to estimate when future earnings and cash flows become more volatile, the estimation of stock value tends to be of similar difficulty or accuracy when capital investment is from small to median, and then becomes less accurate when capital investment increases from median to large. As discussed in Sect. 2, several behavior finance theories all point to the increased mis-pricing of securities such as momentum effect when the estimation of security value becomes more difficult. Therefore, momentum effect tends to be similar when capital expenditure is from small to median, and then increases when capital investment increases from median to large. This explains the impact of scaled capital expenditure on momentum profit.

When capital investment is denoted by the change of scaled capital expenditure or annual accruals, small (negative in value) or large capital investment is more likely to be associated with a large deviation from the normal investment level than intermediate capital investment. A large positive deviation from a normal investment level indicates that firms invest more to take new projects and this tends to bring more uncertainty for future earnings and cash flows. On the other hand, a large negative deviation from a normal investment level in general signals difficulty associated with a firm and this also tends to mean more uncertainty in future cash flows, earnings and stock returns. For instance, these firms might have been under restructuring or discontinued some operations As a result, the volatility of future cash flows, earning and stock returns tends to be larger when capital investment is small or large than when capital investment is intermediate. Therefore, the estimation of stock value tends to become less accurate for the stocks with large or small capital investment. Again, based on the behavior finance theories discussed in Sect. 2, the stocks with small or large capital investment tend to have a stronger momentum effect, and the impact of capital investment on momentum profit exhibits a "U" curve.

We go to our data to empirically verify our explanation. Table 8 summarizes the relationship between recent capital investment and the volatility of earnings and cash flows in the next 5 years, with the portfolio formation period of 6 months. The volatility of earnings (cash flows) is measured as the standard deviation of earnings (operating cash flows) per share over future 5 years scaled by fiscal yearend total assets per share immediately prior to the portfolio formation period. We also examine the volatility of future 5-year stock returns, which is based on the standard deviation of future 60 months' returns. Finally, we measure firm value uncertainty by analyst forecast dispersion of next year earnings per share. While the former three measures may more appropriately measure volatility of earnings, cash flows, and returns across time, analyst forecast dispersion may better measure investors' perception of uncertainty across possible states of the economy.

Panel A presents the volatility results across different levels of capital investment when investment is measured by scaled capital expenditure (I). The volatility for earnings, cash flows and stock returns in the next 5 years is significantly affected by capital investment. Specifically, when capital investment increases from small to median, the volatility of future earnings, cash flows and stock returns tends to decrease. However, this decrease is not significant, as shown in the "V3–V1" column. When capital investment increases from median to large, the volatility of earnings (cash flows, returns) monotonically increases from 0.016 (0.031, 0.103) to 0.033 (0.055, 0.140). The increase is significant with *t*-stat of 3.85 (5.41, 7.73). Therefore, the volatility of future earnings, cash flows and stock returns is almost flat when capital investment is from small to median, and then increases when capital investment increases from median to large. This volatility feature closely matches the impact of capital investment on momentum profit, as shown in panel A of Table 3. Interestingly, dispersion of analyst earnings forecast seems to exhibit a "U" curve across different capital investment levels. Nonetheless, the change of analyst forecast dispersion from before to after capital investment reported in panel D exhibits a flat pattern when capital investment is from small to median, and then increases significantly when capital investment increases from median to large.

Panel B of Table 8 reports the volatility of future earnings, cash flows and stock returns as well as analyst forecast dispersion when capital investment is represented by the change of scaled capital expenditure. Clearly, all measures of volatility show a "U" curve on the

Table 8 Volatility of earnings, cash flows and stock returns, and analyst forecast dispersion for portfolios based on price momentum and capital investments

	V1	V2	V3	V4	V5	V3–V1	V5–V3	V5–V1
Future volatility after investment								
Panel A: V = capital expenditure (I)								
Earnings	0.017 (8.73)	0.014 (5.57)	0.016 (4.80)	0.019 (4.15)	0.033 (4.33)	−0.001 (−1.09)	0.018 (3.85)	0.016 (2.79)
Cash flows	0.034 (10.75)	0.029 (7.94)	0.031 (6.45)	0.035 (5.34)	0.055 (6.24)	−0.003 (−1.46)	0.024 (5.41)	0.021 (3.47)
Returns	0.105 (34.02)	0.098 (25.76)	0.103 (20.01)	0.115 (15.22)	0.140 (15.38)	−0.003 (−0.77)	0.037 (7.73)	0.035 (4.26)
Dispersion	0.071 (19.26)	0.059 (38.36)	0.058 (30.01)	0.060 (23.75)	0.087 (22.57)	−0.013 (−3.76)	0.029 (9.07)	0.016 (2.59)
Panel B: CAPEX change (IC)								
Earnings	0.027 (4.35)	0.016 (5.16)	0.012 (6.09)	0.015 (5.44)	0.026 (4.50)	−0.015 (−3.42)	0.014 (3.61)	−0.001 (−1.01)
Cash flows	0.047 (6.55)	0.031 (6.77)	0.025 (7.26)	0.031 (7.06)	0.048 (6.79)	−0.022 (−5.17)	0.023 (5.81)	0.001 (0.87)
Returns	0.131 (15.20)	0.104 (22.00)	0.095 (26.40)	0.103 (23.38)	0.127 (16.71)	−0.036 (−5.41)	0.033 (5.88)	−0.004 (−2.11)
Dispersion	0.084 (21.77)	0.065 (25.27)	0.055 (23.72)	0.059 (30.05)	0.068 (24.93)	−0.029 (−6.44)	0.014 (4.66)	−0.016 (−3.52)
Panel C: V = accrual (Accr)								
Earnings	0.024 (4.75)	0.016 (5.19)	0.014 (5.22)	0.018 (5.01)	0.028 (4.47)	−0.010 (−4.06)	0.015 (3.79)	0.005 (3.01)
Cash Flows	0.041 (7.77)	0.028 (7.02)	0.027 (7.10)	0.035 (7.45)	0.057 (8.01)	−0.014 (−7.45)	0.031 (7.86)	0.017 (6.90)
Returns	0.123 (18.87)	0.103 (24.76)	0.100 (20.10)	0.112 (18.11)	0.133 (17.24)	−0.023 (−8.11)	0.033 (6.34)	0.010 (3.64)
Dispersion	0.103 (20.97)	0.069 (33.03)	0.061 (25.84)	0.058 (23.98)	0.059 (28.46)	−0.043 (−9.02)	−0.001 (−0.46)	−0.044 (−8.23)
Change of volatility after investment (Ex-post minus Ex-ante)								
Panel D: V = capital expenditure (I)								
Earnings	0.002 (6.22)	0.003 (5.94)	0.004 (4.28)	0.004 (4.18)	0.005 (6.87)	0.001 (1.34)	0.001 (3.35)	0.003 (2.81)
Cash flows	0.004 (3.81)	0.006 (4.46)	0.007 (3.67)	0.008 (4.64)	0.009 (5.90)	0.003 (1.70)	0.002 (2.58)	0.005 (3.18)
Returns	0.005 (0.96)	0.001 (0.28)	−0.000 (−0.07)	−0.001 (−0.15)	−0.004 (−0.68)	−0.005 (−3.76)	−0.004 (−2.38)	−0.009 (−4.44)
Dispersion	−0.005 (−0.84)	−0.007 (−1.46)	−0.003 (−0.82)	0.001 (0.53)	0.006 (2.09)	0.002 (0.51)	0.009 (4.17)	0.011 (2.20)

Table 8 continued

	V1	V2	V3	V4	V5	V3–V1	V5–V3	V5–V1
Panel E: CAPEX change (IC)								
Earnings	0.006 (5.55)	0.004 (5.55)	0.003 (6.11)	0.003 (6.19)	0.005 (5.85)	−0.003 (−4.58)	0.002 (4.81)	−0.001 (−2.58)
Cash flows	0.010 (8.30)	0.007 (6.30)	0.005 (5.27)	0.006 (5.90)	0.009 (8.18)	−0.005 (−9.18)	0.004 (6.75)	−0.001 (−1.62)
Returns	0.002 (0.32)	0.002 (0.38)	−0.001 (−0.15)	0.000 (0.05)	−0.003 (−0.45)	−0.003 (−1.39)	−0.002 (−2.42)	−0.004 (−2.93)
Dispersion	0.012 (3.64)	0.003 (0.95)	−0.007 (−1.71)	−0.006 (−1.45)	0.002 (0.47)	−0.019 (−6.89)	0.009 (3.26)	−0.010 (−3.34)
Panel F: V = accrual (Accr)								
Earnings	0.006 (6.98)	0.004 (7.59)	0.003 (5.89)	0.004 (5.90)	0.005 (7.68)	−0.003 (−4.62)	0.002 (5.40)	−0.001(−1.12)
Cash flows	0.007 (4.83)	0.006 (6.15)	0.006 (5.62)	0.007 (6.38)	0.011 (7.43)	−0.001 (−1.23)	0.005 (6.62)	0.004 (2.63)
Returns	0.007 (1.12)	0.002 (0.39)	0.000 (0.03)	−0.001 (−0.15)	−0.003 (−0.46)	−0.006 (−1.39)	−0.003 (−1.71)	−0.007 (−1.09)
Dispersion	0.010 (2.68)	−0.001 (−0.15)	−0.001 (−0.42)	0.002 (0.68)	0.002 (1.43)	−0.011 (−3.20)	0.003 (1.65)	−0.008 (−2.47)

This table presents measures of firm value uncertainty after capital investment and the change of uncertainty from ex-ante to ex-post capital investment. Table values are time-series averages of median analyst forecast dispersion and median volatility of earnings, cash flows and stock returns for portfolios formed by independent two-way sorts on past returns and capital investments (recent annual capital expenditure scaled by PPE (I), its change from 1 year ago (IC), or accruals (Accr)). Ex-post volatility of future earnings, cash flows, or returns is measured 5 years (year 1–5) after the portfolio formation date whereas the ex-ante volatility of past earnings, cash flows, or returns is measured between year −6 and year −2; ex-post dispersion is measured as analyst forecast dispersion in an April 1 year after formation date whereas ex-ante dispersion is measured in an April 2 years before the formation date. Each year at the end of April all available stocks on NYSE/AMEX/NASDAQ are sorted on past 6-month returns and divided into 5 portfolios. *R1* represents the *loser* portfolio, and *R5* represents the *winner* portfolio. The stocks are also independently sorted into five V portfolios (V1 the lowest and V5 the highest) based on recent capital investments. The stocks at the intersection of the two sorts are grouped together to form portfolios. For each portfolio, we compute median analyst forecast dispersion and median volatility (standard deviation) of future 5 year earnings, cash flows and returns. "Earnings" are annual earnings per share over future 5 years scaled by fiscal yearend total assets per share immediately prior to the portfolio formation period. "Cash flows" are operating cash flows (income before extraordinary items minus accruals) per share over future 5 years scaled by fiscal yearend total assets per share immediately prior to the portfolio formation period. The effects from stock splits or stock dividends are adjusted. Volatility of future returns ("Returns") are based on standard deviation of future 60 months' returns. Forecast dispersion ("Dispersion") is the standard deviation of analyst forecasts (of earnings per share) scaled by the magnitude of mean forecast. Except for analyst forecast dispersion, the numbers in parentheses are Hansen-Hodrick *t*-statistics with 4 moving average lags. To ensure a meaningful sample size in each portfolio, measures of accruals start from 1971, cash flow volatility from 1974, and analyst forecast dispersion from 1992. For measurement of I, IC, and Accr, see notes in Table 1 portfolios sorted on capital investment. For instance, when capital investment (IC) decrease from V1 to V3, return volatility (analyst forecast dispersion) decreases from 0.131 (0.084) to 0.095 (0.055); from V3 to V5, return volatility (analyst forecast dispersion) increases to 0.127 (0.068). Both the decrease and the increase are significant. This volatility "U" curve over capital investment closely resembles the momentum profit "U" curve discussed in Panel B of Table 3.

Panel C of Table 8 reports the volatility measures when capital investment is represented by accruals. Results are qualitatively similar. One exception is that analyst forecast dispersion decreases with accruals. This is not surprising. Accruals are a component of earnings (the other component is cash flow from operations). Lower accruals are thus often associated with loss and it is well known in the accounting literature that some analysts may stop their coverage on firms with poor earnings prospect, thereby reducing forecast accuracy for these loss (low accruals) firms.

Although the cross-sectional difference in post-investment volatility measures across firms with different investment levels may directly support the behavioral explanation for the cross-sectional effect of investment on momentum, it remains an interesting question how the volatility measures change before and after firms make capital investment.[4] Panel D to F of Table 8 report results of this investigation. Volatility of future earnings, cash flows, or returns are measured 5 years (year 1–5) after the portfolio formation date whereas volatility of past earnings, cash flows, or returns are measured between year −6 and year −2. Future dispersion is measured as analyst forecast dispersion in an April 1 year after formation date whereas past dispersion is measured in an April 2 years before the formation date. Most firms release their annual financial statements within 4 months after fiscal year end.

Panel D presents the change of volatility before and after capital investment across different investment levels when investment is measured by scaled capital expenditure (I). When capital investment increases from small to median (V1–V3), the change of volatility of future earnings and cash flows as well as analyst forecast dispersion remains relatively flat. When capital investment increases from median to large (V3–V5), the volatility change increases from 0.004 (0.007, −0.003) to 0.005 (0.009, 0.006). The increase is significant with *t*-stat of 3.35 (2.58, 4.17). Thus, the change of volatility also closely matches the impact of capital investment on momentum profit, as shown in panel A of Table 3. Interestingly, the change of stock return volatility seems decreasing with capital investment. This may be caused by the fact that firm size typically increases with capital investment and it is well known that large firms generally experience lower stock return volatility.

Similar to results in panel B and C, When capital investment is represented by the change of scaled capital expenditure or accruals, the change of volatility of future earnings and cash flows as well as analyst forecast dispersion reported in panels E and F also exhibit a "U" curve.

In summary, high capital investment is not only associated with high uncertainty measures cross-sectionally, but also appears to increase value uncertainty for a same firm over time. Results in Table 8 for the volatility measures and the change of volatility measures generally support our explanation for the empirical results discussed in Sect. 3.

[4] We would like to thank one referee for suggesting this analysis.

5 Conclusions

Capital investment is one important economic variable affecting firms' future cash flows, asset risk and stock returns. While previous research has examined how firms' past capital investment helps to predict future stock returns, this paper addresses another important research question: how does the interaction between past capital investment and past stock returns help to predict future stock returns? Using three different ways to measure capital investment, we all find that capital investment has a significant impact on momentum strategies.

In particular, large capital investment stocks tend to have a larger momentum profit return. When capital investment is represented by scaled capital expenditure, the impact of capital investment on momentum effect has two scenarios. First, capital investment has little impact on momentum profit when capital investment is from small to median. Second, momentum profit monotonically increases when capital investment increases from median to large. When capital investment is represented by the change of scaled capital expenditure or accruals, the impact of capital investment exhibits a "U" curve on the portfolios sorted on capital investment. We also document that the impact of capital investment on momentum profit is robust and cannot be explained by other firm characteristics. While our empirical findings in this paper seem difficult to understand in the modern finance theory framework, we present a simple explanation to help understand the economic intuition behind our empirical results.

Previous research documents empirical evidence about the contrarian trading strategy, which forms a zero cost portfolio by buying losers and shorting winners based on the returns in the past 3–5 years. If we hold this portfolio for 3–5 years, the return from holding this portfolio will be positive. One possible future research subject is to examine how past capital investment affects this contrarian trading strategy.

Another interesting area for future research is to explore alternative variables, financial or non-financial, that may better represent firm value uncertainty. A list of potential candidates may include research and development expenditures, restructuring expenses, and/or management turnover.

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