Investment and the Term Structure of Stock Returns

Sandra Mortal
Fogelman College of Business and Economics
University of Memphis
Memphis, TN 38152
scmortal@memphis.edu

Michael J. Schill
Darden Graduate School of Business Administration
University of Virginia, Box 6550
Charlottesville, VA 22906
schill@virginia.edu

November 2013

Abstract

In this paper we explore the momentum and reversal regularity in the term structure of stock returns. We show that these patterns in stock returns depend highly on leads and lags in firm investment such that there is no residual momentum or reversal effect in stock returns independent of that associated with firm investment. Our results also provide an explanation for the delay in momentum effects observed by Novy-Marx (2012). We propose new explanations consistent with our findings for the large literature on the momentum and reversals regularities.

We thank seminar participants at the University of Memphis and the University of Virginia for helpful comments. Schill acknowledges the financial support of the Darden Foundation.

1. Introduction

Despite a long theoretical basis for the random-walk model of stock returns (Bachelier, 1900), evidence for a systematic pattern to the term structure of stock returns has mounted.[1] A common characterization of this structure is negative serial correlation at a horizon of one month, positive serial correlation at a horizon of six to twelve months, and negative serial correlation at a horizon of 24 to 36 months.[2] Recently, Novy-Marx (2012) documents that the momentum effect is correlated more with intermediate lagged returns (e.g., 7 to 12 months) than more recent returns (e.g, 2 to 6 months). He questions the underlying nature of momentum in observing "this fact is difficult to reconcile with the traditional view of momentum, that rising stocks tend to keep rising, while falling stocks tend to keep falling."

In this paper we propose a holistic explanation for the broader momentum and reversal effects that incorporates a delay mechanism in momentum effects consistent with the observation of Novy-Marx. The delay mechanism is the friction in time associated with firm investment.[3] While firm investment has long been known to influence firm returns,[4] its impact on the serial correlation structure in returns is unexplored.[5] In this paper we document the important linkages between firm investment policy and the term

---

[1] We follow Novy-Marx (2012) who characterizes the serial correlation patterns in firm stock returns as the "term structure of momentum."
[2] See Jegadeesh (1990) for one-month horizons, Jegadeesh and Titman (1993, 2001), Chan, Jegadeesh, and Lakonishok (1996), and Rouwenhurst (1998) for intermediate horizons, and DeBondt and Thaler (1985, 1987), and Cutler, Poterba, and Summers (1991) for long-term horizons.
[3] The delay associated with investment is a standard assumption of neoclassical economics. See Samuelson (1948).
[4] See Tobin (1969), Cocharane (1991), Berk, Green, and Naik (1999), Titman, Wei, and Xie (2004), Cooper, Gulen, and Schill (2008), and Liu, Whited, and Zhang (2009).
[5] Sagi and Seasholes (2007) provide some exploratory evidence in this regard.

structure of stock returns.

Using a large panel of U.S. CRSP-Compustat stocks over the 1976 to 2011 period, we show that (1) past investment predicts returns and past returns predict investment, (2) firm investment is simultaneously associated with positive returns, (3) momentum and reversal patterns in stock returns depend highly on leads and lags in firm investment, and (4) there is no residual momentum or reversal effect in stock returns independent of that associated with firm investment. In showing that the shape of the term structure in stock returns is inherently due to interactions between investment and returns, we propose important implications for the large literature on the momentum and reversals regularities.

Our findings may be consistent with rational or behavioral hypotheses.[6] As a behavioral explanation we propose that first, firm managers maintain incentives to empire build because manager compensation or perquisites are tied to firm scale (Jensen, 1986) and second, investors systematically underappreciate the empire-building incentives of managers, particularly following positive shocks to returns such as that proposed by Titman, Wei, Xie (2003).[7] Based on these two premises, an investment-based

---

[6] As an example of rational explanation, Berk, Green, and Naik (1999) propose a model in which investment induces time variation in expected returns. In their model, time variation in the mix of firm growth options and assets in place affects realized and expected returns in a predictable way. For example, consider a firm with which an exogenous unexpected arrival of a growth option is associated with a positive shock to returns during Period 0. This positive return shock is followed by a subsequent return shock for firms that execute the growth option in Period 1 (generating a momentum effect). The reduction in portfolio risk with the transformation of growth options into assets in place is associated with subsequent lower returns in Period 2 (generating a reversal effect). In such a setting, the momentum and reversal regularity are predictably consistent with an investment-return relation. See Li, Livdan, and Zhang (2009) and Liu, Whited, and Zhang (2009) for other theory that provides intuition consistent with our evidence.

[7] We define empire building as asset expansion that may or may not be associated with economic gains for investors. The observation that abnormal investment is followed by return reversal is not completely new. An expanding body of research explores the asset pricing implications of changes in firm asset levels.

momentum and reversal pattern emerges in the following manner. Suppose a firm experiences a positive exogenous return shock. This shock facilitates asset expansion as the positive wealth effects facilitate an empire-building management to maximize their own utility. Investors respond to the asset expansion by initially bidding up firm stock as investments are undertaken but later bidding down the securities as the magnitude of non-value creating empire building is revealed.[8] The associated pattern is thus that high returns are followed by high returns (as managers invest) and later by low returns (as the empire-building nature of the investment is revealed). The same is true of poor returns as poor returns are associated with subsequent poor returns (as firm investment is constrained) and later followed by high returns (as investors correct their reaction to the underinvestment). An investment-based explanation provides some consistency with the more complex, Novy-Marx delayed structure of momentum due to the friction in time associated with firm investment. One ongoing question in the literature is whether both the momentum and reversal regularities are jointly determined and by what means they are determined. Our findings are consistent with a joint determination of the term structure.

In our tests we use a cross-sectional regression framework to show a very strong relation between investment and past stock returns, as well as between stock returns and

---

Variously referred to as an "investment effect" and tied to capital investment activity or an "asset growth effect" and tied more broadly to changes in total assets, the underlying empirical regularity is a negative correlation between growth in assets and subsequent returns. Representative papers include Fairfield, Whisenant, and Yohn (2003), Titman, Wei, and Xie (2004), Broussard, Michayluk, and Neely (2005), Anderson and Garcia-Feijoo (2006), Lyanders, Sun, and Zhang (2008), Xing (2008), Cooper, Gulen and Schill (2008), and Polk and Sapienza (2009).

[8] Another behavioral explanation is based on bias in expectations by managers and investors as firms tend to overinvest following positive firm returns and over disinvest following negative firm returns. In both of these explanations, the patterns of momentum and reversal are only found to exist in the context of the related investment policy.

past investment. We find that past returns are substantially more important in predicting investment than is past investment. The same thing is true for stock returns: past investment maintains greater power for explaining returns than past returns. We then test conditional features of the serial correlation structure in stock returns and find that return continuation (momentum) exists only among those firms that expand following positive return shocks or contract following negative return shocks. We repeat our tests in a portfolio return framework and observe similar outcomes.

There are a large number of papers that document firm characteristics that interact with momentum effects. Studies that observe interrelations with momentum include findings for share turnover (Lee and Swaminathan, 2000), analyst coverage (Hong, Lim, and Stein, 2000), credit rating (Avramov, Chordia, Jostova, and Philipov, 2013), valuation ratios (Asness, 1997; Daniel and Titman, 2006), trading costs (Lesmond, Schill, and Zhou, 2004), information uncertainty (Zhang, 2006), and dispersion in analyst earnings forecasts (Verardo, 2009).[9] In our tests we control for a number of these known cross-sectional relations (share turnover, bond rating, and analyst coverage). We find that

[9] Other important related papers include the following. Conrad and Kaul (1998) suggests that momentum is simply a manifestation of the cross-sectional variation in firm returns and firm risk. Chordia and Shivakumar (2002), Johnson (2002), and Sagi and Seasholes (2007) argue for rational models based on time-varying risk exposure. Grundy and Martin (2001), Jegadeesh and Titman (2001), and Griffin, Ji, and Martin (2003) provide contradictory evidence to these rational-based explanations. Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999) provide behavioral explanations for momentum based on systematic bias in the way investors under react to information. Hong, Lim, and Stein (2000) find empirical support for an underreaction model in that momentum effects are correlated with the depth of analyst coverage. Over longer horizons investor over reaction has been used to explain the reversal effect (DeBondt and Thaler, 1985). Lo and MacKinlay (1990), Brav and Heaton (2002), and Lewellen and Shanken (2002) provide rational-based models for reversals. Klein (2001) makes the case for a tax-based explanation for which George and Hwang (2004) provide corroborating evidence. Vayanos and Woolley (2013) propose an investment-fund flows based explanation of the two effects.

controlling for these additional variables maintains no impact on our underlying result.

The paper is organized with a data description in Section 2, an empirical analysis description in Sections 3 and 4, a discussion in Section 5, and conclusions in Section 6.

2. Sample and Data Characteristics

We use the sample of all U.S. CRSP-Compustat firms over the period from 1976 to 2011. Since six-month sorting horizons are commonly used in the momentum literature we use a "half-year" timing convention in much of the study. There are some constraints on the frequency with which asset growth rates are updated due to frequency of balance sheet reporting required in the United States. In order to obtain half-year balance sheet data we use the Compustat quarterly files to compute 6 month asset growth rate every quarter. We denote the half-year t+1 as the holding period half-year in our tests. Half-year t-1 is the six-month period before the holding period and half-year t-2 is the six-month period before the t-1 period. We follow a similar reference point for other horizons. To capture firm investment we use the simple measure of growth in total assets. This measure is obtained as the sum of the quarterly percentage growth in total assets for two consecutive quarters (Compustat Data Item 'ATQ'). The measure of investment is motivated by Cooper, Gulen, and Schill (2008) and Lipson, Mortal, and Schill (2011) who find that comprehensive total asset growth maintains greater explanatory power with respect to the cross section of returns than other measures based on components of asset growth.

Panel A of Table 1 provides summary statistics for the stock return and firm investment figures for our sample. Our sample includes nearly two hundred thousand firm-half-year observations where the half-year is measured from January to June and from July to December. The mean value for the cumulative half-year gross return is 6.2% (standard deviation of 31%) and for investment rate is 3.8% (standard deviation of 16%). We also report the serial correlation structure for these two measures. For the returns we observe a correlation coefficient of 0.053 at a lag of one half-year, diminishing to 0.019 for a lag of two half-years, shifting to a negative value of -0.039 at a lag of three half-years, and then to -0.001 at a lag length of four half-years. These values suggest that across the term structure of returns in our sample, there exists a momentum continuation at near-term lengths and a return reversal effect at longer lengths. Since the correlation coefficient for returns is highest at the one-half-year length, our results appear at first pass to be inconsistent with the findings of Novy-Marx (2012). We find that this is not the case when we more formally examine this issue with finer timing conventions in the next section.

To appreciate the correlation between momentum effects and asset growth rates, we also report summary statistics for the associated asset growth rates over the same holding period as the returns. For firm investment we observe a correlation coefficient of 0.053 at a lag of one half-year (precisely the same magnitude as that observed for returns), increasing to 0.182 for a lag of two half-years, declining to 0.009 at a lag of three half-years, and then back to 0.123 at a lag length of four half-years.

To explore the interrelation between returns and investment, we run Fama-MacBeth cross-sectional regressions each non-overlapping half-year. The mean coefficient estimates for the time-series of cross-sectional regressions are reported in Panel B of Table 1. In these tests, we regress firm asset growth rates for half-year t+1 on a number of firm variables that we expect explain investment. LogAssets is defined as the natural logarithm of the total assets of the firm at the end of the previous half-year. The book-to-market ratio is defined following the same dating scheme as LogAssets. To control for outlier effects in the regression, the variables (except for returns) are log transformed and all variables are winsorized at the 0.5% and 99.5% levels. Because the asset growth rate can take non-positive values, we add one to this variable before taking the log. The standard errors are adjusted for serial correlation.

In Regression 1 we include the prior asset growth rates for the firm for half-years t-1, t-2, t-3, and t-4. We observe a significant negative coefficient on the size variable and book-to-market ratio. These signs suggest, not surprisingly, that small, glamor firms tend to invest proportionally more than large, value firms. The signs on the previous investment rates suggest that investment rates with lags of one and two years maintain the most explanatory power. The coefficients on the intervening half-years maintain no effect (lag -1) to a significant negative sign (lag -3). Clearly, firm asset growth rates maintain a curious time-series pattern that merits further investigation.

In the second specification, we omit the past investment rates and add the past half-year stock return values. We observe very strong positive association between firm returns and firm investment. The t-statistics with the stock returns are 14.6, 16.3, 15.9, and 11.7 for returns with lag -1, -2, -3, -4, respectively. The rise in the mean r-squared value from Regression 1 to Regression 2 indicates that the four lagged return measures maintain greater explanatory power in predicting investment than do the four lagged investment rates. In Specification 3 we add the contemporaneous return for time t+1. Firm returns are highly positively correlated contemporaneously with firm investment.

Firms that expand tend to have high returns and firms that contract have low returns. In Specification 4 we add both growth rates and stock returns as regressors. We observe that the stock returns maintain their importance in explaining the cross-section of firm investment rates: firms with strong past and contemporaneous stock returns maintain substantially higher asset growth rates. The one coefficient that substantially changes is that on the single lag investment rate. The coefficient on AGrowth (-1) declines from 0.004 (t-stat=0.64) to -0.045 (t-stat= -7.82). These changes in sign are suggestive of the interrelations we document in this paper. In explaining investment, past and contemporaneous returns maintain a greater explanatory power than do past investment. Specifically, past and contemporaneous returns explain higher investment rates.

3. Regression Tests

The Fama-Macbeth set up can also be used to document the momentum and reversal effect. We follow Novy-Marx (2012), more exactly we use monthly gross returns as the dependent variable and define our lagged return variables in the following way. The variable “Past Month Return” is defined as the monthly gross return for the prior month. The variable “Ret(-1)” is defined as the cumulative return for months -2 to -6 prior to the formation of the dependent variable. The variable “Ret(-2)” is defined as the cumulative return for months -7 to -12 prior to the formation of the dependent variable. Book-to-market ratio and market cap, defined as the market value of equity divided by 1000, are both measured as of the end of the quarter before we measure the dependent variable. Asset growth is the 6 month growth in assets. The timing -1 refers to the 6-month growth as of the quarter before we measure the dependent variable. To control for outlier effects in the regression, all variables except returns are again log transformed and all independent variables are winsorized at the 0.5% and 99.5% levels and the standard errors are adjusted for serial correlation.

In our first regression specification, we regress firm returns on the size of the firm's equity capitalization, the book-to-market ratio, the past month return, and the past firm returns of lags one and two. Results are reported in panel A of Table 2. In an equal-weighted set up, we observe a positive correlation for book-to-market ratio and a negative correlation with past month return as expected. We also note a positive association with the past return of lag one and an even stronger association with past returns from months -7 to -12 (half-year -2). In documenting the well-known momentum effect in stock returns, we also replicate the results of Novy-Marx (2012) as the coefficient on lag -1 of 0.006 (t-stat = 1.74) is smaller than that associated with lag -2 of 0.007 (t-stat = 2.73). As argued by Novy-Marx, this finding of stronger correlation with more dated returns is inconsistent with the traditional view of momentum being driven by a continuation of winners continuing to win and losers continuing to lose. In the next section we test an alternative explanation.

3.1. Momentum and Investment

Returns have been found to be correlated with past investment rates (see Titman, Wei, and Xie, 2004; Cooper, Gulen, and Schill, 2008; and Liu, Whited, and Zhang, 2009). In Specification 2 of Panel A, we omit the past half-year stock return values and add the contemporaneous and past investment rates modeled by asset growth. We observe strong association between firm returns and firm investment. The t-statistics with the past investment are large at 5.13, -7.48, -5.32, and -4.20 for asset growth with lag -1, -2, -3, -4, respectively. The negative coefficients are consistent with the asset growth effect in stock returns (Cooper, Gulen, and Schill, 2008). We also observe a particularly strong correlation with contemporaneous investment. The coefficient on AGrowth(+1) is 0.078 (t-stat = 21.96). Clearly, firms that invest tend to be contemporaneously associated with high returns.

In Specification 3 we add both stock returns and growth rates as regressors. We observe that the asset growth rates maintain their importance in explaining the cross-section of firm stock returns: near-term investment is positively correlated with returns and long-horizon investment is negatively correlated with returns. With the asset growth rate values included, there is a striking effect on momentum as the coefficient on Ret(-1) drops from 0.006 (t-stat = 1.74) to -0.004 (t-stat = -1.03) and the coefficient on Ret(-2) drops from 0.007 (t-stat = 2.73) to 0.002 (t-stat = 0.73). The tests confirm that the momentum observed by Novy-Marx is conditional on prevailing firm investment policy. The inclusion of past and contemporaneous investment rates subsumes the explanatory power of past returns. In effect past returns maintain no predictive power outside of the correlation provided by investment rates.

There is some evidence that the momentum effect is particularly strong among large cap firms. In the remaining specifications we weight the firm observations by the natural logarithm of firm market capitalization. In Specification 4 we observe that the Novy-Marx result holds in our weighted regression set up. The coefficient on Ret(-2) maintains greater explanatory power than Ret(-1) and the t-statistic is equal to 2.52. When we include the firm investment policy values, we again see that the explanatory power of past return evaporates (Specification 5). The results portrayed in Table 2 illustrate a substantial association between contemporaneous and previous stock returns and contemporaneous and previous investment rates.

The existing literature indicates that the correlation structure is accentuated with the magnitude of past performance in that the serial correlation is higher for winners (firms with strong past performance) and losers (firms with weak past performance). Panel B accommodates a non-linear structure in predictive power by identifying winners and losers with indicator variables. In the table we report estimates of cross-sectional regressions similar to those in Panel A but with strong past performance indicated with a variable D(Ret(-1)=High) that indicates that the firm stock return was among the top 20 percent of all firms in the sample in half-year -1 (months -2 to -6) and variable D(Ret(-1)=Low) that indicates that the firm stock return was among the bottom 20 percent of all firms in the sample in half-year -1 (months -2 to -6). We also include indicator variables for strong and poor past performance for half year -2, which we define in identical fashion. Regression 1 shows the mean coefficients estimates in a specification that includes the two past return indicators and the following control variables: size, book-to-market ratio, and past month return. The estimates show a strong momentum effect with coefficients of 0.006 (t-stat = 4.85) for D(Ret(-1)=High) and -0.006 (t-stat = -3.37) for D(Ret(-1)=Low). The coefficients are similar for returns in half-year -2. The regressions shows strong evidence that winners tend to continue to win in the near term and losers tend to continue to lose in the near term.

In Regression 2, two regressors are added: indicator variables D(AGrowth(+1)=High) to indicate top 20 percentile investment rates in half-year +1 and

D(AGrowth(+1)=Low) to indicate bottom 20 percentile investment rates in half-year +1. These variables are highly significant. Top 20th percentile investment is associated with strong positive returns and bottom 20th percentile investment is associated with strong negative returns. The inclusion of these investment variables reduces but does not eliminate the explanatory power of past returns as it did with the continuous measures in Panel A. In Regression 3 we interact these investment indicators with the past return variables. We find these interaction effects to be highly important. Firms with past high returns and high subsequent investment are associated with large subsequent returns while the opposite is true for firms with poor returns and low investment. The coefficients suggest strong serial correlation for winner firms that subsequently invest and for loser firms that subsequently disinvest. The inclusion of these interactions eliminates the statistical significance of the past return variables in isolation. The coefficients on the past returns variables are no longer significantly different from zero at the conventional levels, with a value of 0.002 (t-stat = 1.37) for D(Ret(-1)=High), -0.001 (t-stat = -0.51) for D(Ret(-1)=Low), 0.000 (t-stat = 0.20) for D(Ret(-2)=High), and -0.002 (t-stat = -1.17) for D(Ret(-2)=Low). We repeat this exercise with weighted regressions. We again find a similar effect. The regression estimate indicates that the tendency for winners to continue to win is isolated to be among only those winners that subsequently are among the firms with the highest investment rates. Moreover, the tendency for losers to continue to lose is isolated to be among only those losers that subsequently are among the firms with the lowest investment rates.

The regression framework allows us to control for other firm characteristics that have been shown to explain momentum effects. For example, Lee and Swaminathan

(2000) document that momentum effects are correlated with the level of share turnover. Avramov, Chordia, Jostova, and Philipov (2013) document that momentum is isolated among firms with non-investment grade credit ratings. Hong, Lim, and Stein (2000) observe that analyst coverage provides an important cross-sectional effect in momentum. They observe that momentum effects are larger for firms with little analyst coverage.

To test whether our investment analysis is independent of these cross-sectional momentum effects, we run our regression tests on sub samples of firms that demonstrate the particular characteristic from the literature. We report these results in Table 3. In these tests, the dependent variable is the half-year gross return and the regression is estimated each half-year, rather than monthly. D(Ret(-1)=High) is defined as indicating that returns in half year -1 (in this table defined for simplicity as months -1 to -6) are among the top 20 percent. A similar definition follows for the other indicator variables.

In the first regressions we provide a baseline full sample test. The result is similar to that of Panel B in Table 2, the momentum effect is conditional on contemporaneous investment policy. In specification 3 and 4 we follow Lee and Swaminathan and restrict the sample to only include those firms that maintain turnover ratios among the top tercile for the previous half-year. Turnover is defined as the 6 month average of monthly volume scaled by shares outstanding. Both variables are obtained from CRSP. For high turnover stocks, the explanatory power of past performance in isolation found in the base case (Regression 3) is eliminated once the interaction terms are included. The coefficient on D(Ret(-1)=High) drops to 0.002 (t-stat = 0.30) and the coefficient on D(Ret(-1)=Low) drops to -0.004 (t-stat = -0.61) in Specification 4.

In specifications 5 and 6 we restrict the sample to only include those firms that maintain non-investment grade or missing credit ratings for the previous half-year. Credit rating is from Compustat and is the S&P issuer rating. Following Avramov, et al., a firm is non-investment grade if its credit rating is below BB+. In this test the explanatory power of past performance in isolation found in the base case (Regression 5) is again eliminated once the interaction terms with investment are included. The coefficient on D(Ret(-1)=High) drops to 0.001 (t-stat = 0.17) and the coefficient on D(Ret(-1)=Low) drops to -0.010 (t-stat = -1.51).

In Regressions 7 and 8, we conduct a final cross-sectional test for the subsample that includes only those firms for which there is no analyst coverage on IBES during the month prior to the holding period. In Regression 7 following Hong, Lim, and Stein (2000), we observe that firms with no analyst coverage appear to maintain a particularly large momentum effect. When we include the interaction variables with investment, again the explanatory power of past returns in isolation are significantly reduced. For Regression 8, the coefficient on D(Ret(-1)=High) drops to 0.006 (t-stat = 1.15) and the coefficient on D(Ret(-1)=Low) drops to -0.013 (t-stat = -1.79). These tests in Table 3 indicate that our investment-based explanation of momentum is not simply a manifestation of some of the existing cross-sectional effects already in the literature.

3.2. Reversal and Investment

We conduct a similar exercise for the reversal effect. In Table 4 we include past return-based dummy variables that are defined based on half-year -3. In regression specification 1 we observe that the mean coefficient estimate for D(Ret(-3)=High) is -

0.016 (t-stat = -3.02) and the coefficient on D(Ret(-3)=Low) is positive at +0.005 but not significant (t-stat 0.99). The test confirms a reversal effect in that past winners tend to do poorly over long horizons. In specification 2 we add an additional set of dummy variables that indicate whether the subsequent investment was among the top 20th D(AGrowth(-2)=High) or bottom 20th levels D(AGrowth(-2)=low). We also estimate coefficients for interaction values in which past winners subsequently expand and past losers subsequently contract. In this specification we observe that the coefficients on the interaction terms are not significant but their inclusion creates a dampening effect on the reversal result. The coefficient on D(Ret(-3)=High) is now -0.011 (t-stat = -2.29) and the coefficient on D(Ret(-1)=Low) is now 0.004 (t-stat 0.94). The evidence suggests that the reversal effect is not eliminated by the single value of subsequent investment.

In Specification 3 we add an additional set of dummy variables that indicate whether the investment in half-year -3 was among the top 20th D(AGrowth(-3)=High) or bottom 20th levels D(AGrowth(-3)=Low). We also estimate coefficients for interaction values in which past winners expand and past losers contract. In this specification we observe that the coefficients on the interaction terms are significant for the winners as in the baseline regression. In our final specification we include both sets of investment variables. We note that their inclusion maintains an important effect on the base reversal variables. The coefficient on D(Ret(-3)=High) is now -0.006 (t-stat = -1.41) and the coefficient on D(Ret(-3)=Low) is now 0.004 (t-stat 0.89). Controlling for the firm's investment policy drives out the independent explanatory power of past returns.

These tests provide evidence that both the momentum and reversal effects are jointly explained by the firm's investment policy. The findings are consistent with return shocks that are associated with subsequent investment shocks, and investment that is positively correlated with contemporaneous returns and negatively correlated with subsequent returns. We find empirical support for the testable implication that the momentum and reversal effects in returns exist only in association with the prescribed firm investment policy.

4. Portfolio returns

4.1. Return Effects

We now turn to traditional portfolio tests to more closely examine the interrelation between returns and investment. To replicate the underlying return effects, we form momentum portfolios in a manner similar to Jegadeesh and Titman (1993). Each month securities are sorted into quintiles on the basis of their returns in the past 6 months. The position is then held for 6 months, and each month, the strategy closes out the position initiated 6 months ago. Hence, under this trading strategy we revise the weights on 1/6th of the securities in the entire portfolio in any given month and carry over the rest from the previous months.

In Panel A of Table 5 we report the mean monthly gross returns and Fama-French three-factor alphas by past return quintile. We observe the common momentum effect with a monotonic increase in mean returns based on past half-year performance. The difference in monthly gross returns for the winners (1.52%) and the losers (0.63%) is 0.89% (t-stat = 3.49). The difference in three-factor alphas for the winners (0.32%) and the losers (-0.70%) is 1.03% (t-stat = 3.98). Our sample appears to generate the common momentum effect in stock returns over a six-month horizon. We observe a strong correlation between past returns and subsequent asset growth rates. Firms in the low return quintile maintain a mean half-year asset growth rate of 1.1%, whereas firms in the high return quintile maintain a mean half-year asset growth rate of 7.2%. The difference in asset growth rates is highly statistically significant, consistent with the previous observation that past winners tend to invest substantially more than past losers.

In Panel B we repeat the same exercise but with sorts based on returns for half-year -2 following the extended delay of Novy-Marx (2012). We observe that high minus low return spreads are again positive and significant with a spread of 0.32% (t-stat = 2.08) for gross returns and 0.44% (t-stat = 3.03) for adjusted returns. Although significant the spread is smaller than that observed at a six-month horizon. Because of the half-year convention used to measure our dependent variable, this test is not able to replicate the extended delay in momentum documented by Novy-Marx. Nevertheless, we continue to observe strong associations with investment, as the asset growth rate spread for the subsequent period (half-year -1) is strongly significant with an investment spread of 5.5%.

Finally, in Panel C we report the subsequent mean returns and asset growth rates for firms sorted based on their returns in half-year -3. This lag structure represents a delay of more than 12 months. Based on this sorting we observe a significant reversal in subsequent returns. The mean monthly gross returns for stocks in the low-return quintile are 1.34% and the returns for stocks in the high-return quintile are 0.90% for a statistically significant difference of -0.43% (t-stat = -3.45). The mean monthly three-factor alpha for stocks in the low-return quintile are -0.01% and the returns for stocks in the high-return quintile are -0.30% for a statistically significant difference of -0.29% (t-stat = -2.51). This evidence is consistent with return reversal as in DeBondt and Thaler (1985, 1987). We also report the associated asset growth rates. Again we see an ongoing increase in half-year asset growth with the low return firms at 2.5% and the high return firms at 6.7%. The high reversal firms are associated with high investment rates. The findings in this table are consistent with a term structure of stock returns that is positively correlated over moderate horizons and negative over long horizons as well as a predictable regularity in investment rates.

4.2. Investment effects

We now use two-way independent sorts to identify the relation of the momentum and reversal effects with respect to investment policy. To examine momentum effects, we sort firms independently into quintiles by returns in half-year -1 and by asset growth rate in half-year +1. This sorting is motivated by the evidence observed that the momentum effect is isolated among those firms with extreme high or low investment rates. Our test is to observe whether momentum spreads are uniform across subsequent investment rates or rather concentrated among those firms with subsequent extreme investment or disinvestment as in Table 2. In these independently formed portfolios the mean number of stocks in the portfolios range from 70 in the low growth-high past returns portfolio to 173 in the low growth-low past returns portfolio.

We report the mean monthly-adjusted returns in Panel A of Table 6. The first pattern we observe is that low growth firms systematically maintain low adjusted returns across all return quintiles and high growth firms maintain high returns across all return quintiles. Investment is contemporaneously associated with high returns. Next, we look across past return quintiles and observe that the significant momentum spreads are isolated to only those firms that experience subsequent extreme asset growth rates. For firms with the highest asset growth rates, the high-minus-low half-year momentum spread is 0.91% (t-stat = 3.81). For firms with the lowest asset growth rates, the high-minus-low momentum spread is 0.79% (t-stat = 2.91). For the meddling investment group (investment quintile 3), there is no momentum spread as the winner-less-loser spread is -0.04% (t-stat = -0.18). The variation in momentum effect is highly dependent on investment policy and driven by the firms in the extreme portfolios. The firms with high return followed by high investment experience the highest adjusted half-year returns of 1.3%. The firms with low return followed by low investment experience the lowest adjusted half-year returns of -2.1%. The evidence is consistent with an investment-based view of momentum in that momentum effects are determined jointly with the prescribed return-based investment policy. Figure 1 provides a graphical representation of the nature of the momentum effect. The figure simply plots the mean abnormal return values from the two-way sort. It is clear from the graph that the momentum effect is isolated among the firms in the extreme investment rate quintiles.

We conduct a similar test for return reversals. To examine reversal effects, we sort firms independently into quintiles by returns in half-year -3 and by asset growth rate in half-year -2. This sorting is motivated by the assertion that the reversal effect is isolated among those firms in which a return shock motivated subsequent investment. Our test is to observe whether reversal spreads are uniform across subsequent investment rates or rather concentrated among those firms with subsequent extreme investment or disinvestment. The mean number of stocks in the portfolios vary from 66 in the high growth-low returns portfolio to 140 in the low growth-low returns portfolio.

We report the mean monthly risk-adjusted returns in Panel B of Table 6. As we look at quintiles based on past returns we observe across the high-minus-low reversal spreads that the significant spreads are again isolated to only those firms that experience subsequent extreme asset growth rates. For firms with the highest asset growth rates, the high-minus-low reversal spread is -0.25% (t-stat = -1.98). For firms with the lowest asset growth rates, the high-minus-low reversal spread is -0.25% (t-stat = -1.91). For the meddling investment group investment quintile 3), the reversal spread is -0.15% (t-stat = -1.20). Again, the variation in the reversal effect is driven by the firms in the extreme portfolios. Since our portfolio tests only allow us to control for investment at one point in time, the results in Table 4 provide a more complete description of the interactions of various leads and lags. Still, the evidence is consistent with an important role for investment in the reversal pattern as reversal effects are determined jointly with the prescribed return-based investment policy and correlated with the unwinding reversal of momentum overreaction.

Figure 2 provides a long horizon presentation of the behavior of returns sorted by past returns and contemporaneous investment rates. In Panel A, we show the subsequent monthly portfolio returns of the firms with high past returns (winners) sorted by subsequent investment rates over the 24 months following the return sorting period. The graph shows the overall mean return for these firms in the light dotted line. We note over the first six months that the returns for the winners are broadly distributed around the overall mean return. Once subsequent investment is controlled for, there is no abnormal momentum return for the winner firms. Over months 7 through 12 the reversal pattern of low returns is exclusively among the higher investment firms. The pronounced momentum and reversal is most acute for the high investment firms. In Panel B, we show the same time-series pattern for the low performance firms (losers). Again we see that over the first half-year the portfolio returns are evenly distributed around the mean return. The underperformance is concentrated among the firms with little investment. For the loser firms, the reversal effect is less pronounced for the low investment firms. The most important contributor to the reversal is again among the high growth firms following the asset growth literature.

Given the important interaction between investment and past return effects, one wonders about the ex-ante predictability of returns associated with this effect. Since the sorting variable used to examine the reversal effect are known prior to the holding period, these returns are to some extent "tradable strategies." However, since the investment rates used to examine the momentum strategies are realized contemporaneously with the holding period, the interaction effect documented in this paper is not "tradable." To identify what abnormal returns might be observable ex-ante, we use the predicted value from a regression similar to Regression 4 in Panel B of Table 1 except that Ret(+1) is not included as a regressor. The coefficients of Regression 3 show how important past returns are in predicting firm investment. This predictability may generate a predicted value that is useful is explaining subsequent firm returns. In Table 7 we use this predicted investment in our two-way sort with past returns. Since we only use a predicted value of asset growth in our sort, all values in the sorting are available at the end of Time -1.

First, we observe a strong negative relation between predicted growth and subsequent returns for the firms with poor past returns similar to the Cooper et al. asset growth effect. In contrast we observe a positive relation between predicted growth and subsequent returns for the firms with strong past returns similar to the realized investment effect we've observed throughout this paper. This observation underlines the important interaction between firm investment and past returns. Second, we observe a strong correlation between momentum patterns and predicted investment rates. Among the predicted low growth firms, the momentum effect is near zero (monthly momentum spread of 0.38% (t-stat = 1.30)). The momentum spread climbs to 1.67% (t-stat = 6.14) for firms with high-predicted asset growth. This test confirms that the interrelation between investment and past returns is also of interest in capturing the cross-section of returns on an ex-ante basis.

5. An Investment-based Explanation of Momentum and Reversal

Our empirical analysis confirms several important patterns for firm investment and returns. First, investment is correlated with past stock returns. Our sample indicates that high returns predict high investment and low returns predict low investment. Past returns are a very strong predictor of investment and in fact more important than past investment. Second, stock returns are correlated with contemporaneous investment. Within the sample we observe that high investment is associated contemporaneously with high stock returns and low investment is associated contemporaneously with low stock returns.

Based on the analysis in this paper, we suggest that the combination of these two patterns is sufficient to generate the momentum effect in stock returns. This observation implies that there is no continuation effect inherent in returns themselves but only in that high returns are associated with subsequent high investment and subsequent high investment is associated contemporaneously with high returns. In parallel manner, low returns are associated with subsequent low investment and such low investment is associated contemporaneously with low returns. In this way, winners tend to win and losers tend to lose.

A third pattern documented in this paper is the asset growth effect, that investment is negatively correlated with subsequent returns. Our sample indicates that high investment is associated with low subsequent returns and that low investment is associated with high subsequent returns. Combining this observation with the other two patterns generates a prediction of reversals in stock returns.

There may be several explanations for this set of three empirical regularities. The explanation we offer is a behavioral one that we call "empire-building myopia." With such, consider a market in which first, firm managers maintain incentives to empire build because manager compensation or perquisites are tied to firm scale (Jensen, 1986), and second, investors systematically underappreciate the empire-building incentives of managers, particularly following positive shocks to returns such as that proposed by Titman, Wei, and Xie (2003). Based on these two premises, an investment-based momentum and reversal pattern emerges in the following manner. Suppose a firm experiences a positive exogenous return shock. This shock facilitates asset expansion as the positive wealth effects facilitate empire-building management to maximize their own utility. Investors respond to the asset expansion by initially bidding up firm stock as investments are undertaken but later bidding down the securities as the magnitude of non-value creating empire building is revealed.

Our findings may also be consistent with rational explanations. Berk, Green, and Naik (1999) propose a model in which investment induces time variation in expected returns. In their model, time variation in the mix of firm growth options and assets in place affects realized and expected returns in a predictable way. For example, consider a firm with which an exogenous unexpected arrival of a growth option is associated with a positive shock to returns during Period 0. This positive return shock is followed by a subsequent return shock for firms that execute the growth option in Period 1 (generating a momentum effect). The reduction in portfolio risk with the transformation of growth options into assets in place is associated with subsequent lower returns in Period 2 (generating a reversal effect). In such a setting, the momentum and reversal regularity are predictably consistent with an investment-return relation.

6. Conclusions

In this paper we explore the momentum and reversal nature of the term structure of stock returns. We document that leads and lags in investment policy maintain important linkages to the serial correlation structure. Using a large panel of U.S. CRSP-Compustat stocks over the 1976 to 2011 period, we show that (1) past investment predicts returns and past returns predict investment, (2) firm investment is simultaneously associated with positive returns, (3) momentum and reversal patterns in stock returns depend highly on leads and lags in firm investment policy, and (4) there is little residual momentum or reversal in stock returns independent of that associated with firm investment. Furthermore, by documenting that the momentum effect is driven by firm investment our evidence is consistent with the Novy-Marx (2012) delay in momentum effects. In showing that the shape of the term structure in stock returns is inherently due to interactions between investment and returns, we propose important implications for the large literature on the momentum and reversals regularities.

References

Anderson, C., and L. Garcia-Feijoo, 2006, Empirical evidence on capital investment, growth options, and security returns, Journal of Finance 61, 171-194.

Asness , Clifford S., 1997, The Interaction of Value and Momentum Strategies, *Financial Analysts Journal* 53, 29-36.

Avramov, Doron, Tarun Chordia, Gergana Jostova, and Alexander Philipov, 2013, Anomalies and Financial Distress**,** *Journal of Financial Economics* 108 ,139-159.

Bachelier, Louis, 1900, Theorie de la speculation, Annales Scientifiques de l'Ecole Normale Superieure 3 (17), 21-86.

Barberis, N., A. Shleifer, and R,. Vishny, 1998, A model of investor sentiment, Journal of Financial Economics 49, 307-343.

Berk, J., R. Green, and V. Naik, 1999, Optimal investment, growth options, and security returns, *Journal of Finance* 54, 1153-1608.

Brav, A., and J. B. Heaton, 2002, Competing theories of financial anomalies, Review of Financial Studies 15, 575-606.

Broussard, J. P., D. Michayluk, and Walter Neely, 2005, The role of growth in long-term investment returns, *Journal of Applied Business Research* 21, 93-104.

Chan, L.K.C., N. Jegadeesh, and J. Lakonishok, 1996, Momentum strategies, The Journal of Finance 51, 1681-1713.

Chordia, Tarun, and Lakshmanan Shivakumar, 2002, Momentum, business cycle and time-varying expected returns, Journal of Finance 57, 985-1019.

Cochrane, John H., 1991, Production-based asset pricing and the Link between stock returns and economic fluctuations, *The Journal of Finance* 46, 209-237.

Conrad, J. and G. Kaul, 1998, An anatomy of trading strategies, Review of Financial Studies 11, 489-519.

Cooper, M., H. Gulen, and M. Schill, 2008, Asset growth and the cross-section of stock returns, Journal of Finance 68, 1609-1651.

Cutler, David N., James M. Poterba, and Lawrence H. Summers, 1991, Speculative dynamics, Review of Economic Studies 58, 529-546.

Daniel, Kent, David Hirshleifer and Avanidhar Subrahmanyam, 1998, A theory of overconfidence, self-attribution, and security market under and over-reactions, Journal of Finance 53, 1839-1885.

Daniel Kent, and Sheridan Titman, 2006 Market reactions to tangible and intangible information, Journal of Finance 61(4), 1605-1643.

DeBondt, Werner F.M., and Richard Thaler, 1985, Does the stock market overreact? Journal of Finance 40, 793-805.

DeBondt, Werner F.M., and Richard Thaler, 1987, Further evidence on investor overreaction and stock market seasonality, Journal of Finance 42, 557-581.

Fairfield, Patricia M., J. Scott Whisenant, and Teri Lombardi Yohn, 2003, Accrued earnings and growth: Implications for future profitability and market mispricing, The Accounting Review 78, 353–371.

Fama, Eugene F., and James MacBeth, 1973, Risk, return, and equilibrium: Empirical tests,
Journal of Political Economy 81, 607-636.

George, T. J., and C. Hwang, 2004, The 52-week high and momentum investing, Journal of Finance 59, 2145-2176.

Griffin, John M., Susan Ji, and J. Spencer Martin, 2003, Momentum investing and business cycle risk: Evidence from Pole to Pole, Journal of Finance 58, 1515-1547.

Grundy, Bruce D., and J. Spencer Martin, 2001, Understanding the nature of the risks and source of rewards to momentum investing, Review of Financial Studies 14, 29-78.

Hong, Harrison, Terrence Lim, and Jeremy Stein, 2000, Bad news travels slowly: Size, analyst coverage, and the profitability of momentum strategies, Journal of Finance 55, 265-295.

Hong, Harrison, and Jeremy Stein, 1999, A unified theory of underreaction, momentum trading, and overreaction in asset markets, Journal of Finance 54, 2143-2184.

Jegadeesh, Narasimhan, 1990, Evidence of predictable behavior of security returns, Journal of Finance 45, 881-898.

Jegadeesh, Narasimhan, and Sheridan Titman, 1993, Returns to buying winners and selling losers: Implications for stock market efficiency, Journal of Finance 48, 65-91.

Jegadeesh, Narasimhan, and Sheridan Titman, 2001, Profitability of momentum strategies: An evaluation of alternative explanations, Journal of Finance 56, 699-720.

Jensen, Michael C., 1986, Agency costs of free cash flow, corporate finance, and takeovers, American Economic Review 76, 323-329.

Johnson, Timothy, 2002, Rational momentum effects, Journal of Finance 57, 585-608.

Klein, P., 2001, The capital gain lock-in effect and long-horizon return reversal, Journal of Financial Economics 59, 33-62.

Lee, C. M. C., and B. Swaminathan, 2000, Price momentum and trading volume, Journal of Finance 55, 2017-2069.

Lesmond, David A., Michael J. Schill, and Chunsheng Zhou, 2004, The illusory nature of momentum profits, Journal of Financial Economics 71, 349–380.

Lewellen, J., and J. Shanken, 2002, Learning, asset-pricing tests, and market efficiency, Journal of Finance 57, 1113-1145.

Li, Erica X. N., Dmitry Livdan, and Lu Zhang, 2009, Anomalies, *The Review of Financial Studies* 22, 4301-4334

Liu, Laura X., Toni M. Whited, and Lu Zhang, 2009, Investment-Based Expected Stock Returns, Journal of political economy 117, 1105-1139.

Lo, A.W., and A.C. MacKinlay, 1990, When Are Contrarian Profits Due to Stock Market Overreaction? Review of Financial Studies 3, 175–205.

Lyanders, Evgeny, Le Sun, and Lu Zhang, 2008, The new issues puzzle: Testing the investment based explanation, Review of Financial Studies 21, 2825-2855.

Novy-Marx, Robert, 2012, Is Momentum Really Momentum?, *Journal of Financial Economics* 103, 429–453.

Polk, Christopher, and Paola Sapienza, 2009, The stock market and corporate investment: A test of catering theory, Review of Financial Studies 22, 187-217.

Rouwenhorst, K.G., 1998, International momentum strategies, Journal of Finance 53, 267–284.

Sagi, Jacob, and Mark Seasholes, 2007, Firm-specific attributes and the cross-section of momentum, Journal of Financial Economics 84, 389-434.

Samuelson, Paul A., 1948, Economics: An introductory analysis, McGraw-Hill.

Titman, S., K. Wei, and F. Xie, 2004, Capital investments and stock returns, Journal of Financial and Quantitative Analysis 39, 677-700.

Tobin, James, 1969, A General Equilibrium Approach to Monetary Theory, *Journal of Money, Credit and Banking* 1, 15-29.

Vayanos, Dimitri, and Paul Woolley, An institutional theory of momentum and reversal, The Review of Financial Studies 26, 1087-1145.

Verardo, Michela, 2009, Heterogeneous beliefs and momentum profits, Journal of Financial And Quantitative Analysis 44, 795–822.

Xing, Yuhang, 2008, Interpreting the value effect through the Q-theory: an empirical investigation, The Review of Financial Studies 21, 4, 1767-1795.

Zhang, Frank X., 2006, Information uncertainty and stock returns, *The Journal of Financ*e 61, 105-137.

Table 1. Summary Statistics

This table reports summary statistics and regression results for gross stock returns and asset growth rates for a sample that includes all U.S. CRSP-Compustat firms from 1976 to 2011. The holding period for both returns and growth rates is on a non-overlapping half-year basis, where the half-hear is measured from January to June and from July to December. The asset growth rate (AGrowth) is defined as the six-month growth in total assets from the quarterly Compustat file. The gross stock return is the cumulative 6-month total return for the firm from CRSP. In Panel B, we report Fama-MacBeth equal-weighted cross-sectional regression results for asset growth rates. We run non-overlapping regressions every six months. In these regressions, in addition to the variables in Panel A, we include as regressors: LogAssets which is defined as the natural logarithm of the total assets of the firm and the book-to-market ratio both variables measured as of the end of the fiscal quarter before we measure the dependent variable. The variable timings vary, and we include in parentheses the timings in relation to the dependent variable in half-years, such that -1 is the half-year before the dependent variable and +1 is the half-year contemporaneous to the dependent variable. To control for outlier effects in the regression, all variables (except returns) are log transformed and all variables are winsorized at the 0.5% and 99.5% levels. Because the asset growth rate can take non-positive values, we add one to this variable before taking the log. The standard errors are adjusted for serial correlation, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

Panel A. Summary Statistics

	Gross returns (Ret)	Asset growth rate (AGrowth)
Number of firm half-years	191,781	189,043
Mean	0.0619	0.0380
Std. Deviation	0.3057	0.1623
Serial correlation of lag		
-1	0.0533	0.0525
-2	0.0187	0.1823
-3	-0.0391	0.0088
-4	-0.0011	0.1231

Table 1. (Continued)

Panel B. Cross-sectional Regression Estimates

	(1)	(2)	(3)	(4)
	AGrowth (+1)	AGrowth (+1)	AGrowth (+1)	AGrowth (+1)
Intercept	0.034*** (5.71)	0.032*** (5.84)	0.029*** (6.12)	0.021*** (4.84)
LogAssets	-0.003*** (-3.99)	-0.002*** (-3.44)	-0.002*** (-3.78)	-0.002*** (-3.40)
Book-to-market ratio	-0.038*** (-17.53)	-0.028*** (-16.69)	-0.030*** (-15.49)	-0.025*** (-15.04)
Agrowth(-1)	0.004 (0.64)			-0.045*** (-7.82)
Agrowth(-2)	0.133*** (11.37)			0.119*** (11.03)
Agrowth(-3)	-0.026*** (-3.41)			-0.011 (-1.65)
Agrowth(-4)	0.065*** (6.90)			0.089*** (9.83)
Ret(+1)			0.091*** (22.16)	0.093*** (21.61)
Ret(-1)		0.077*** (14.58)	0.071*** (14.74)	0.077*** (16.12)
Ret(-2)		0.046*** (16.32)	0.044*** (15.39)	0.045*** (17.21)
Ret(-3)		0.030*** (15.92)	0.032*** (17.32)	0.029*** (16.28)
Ret(-4)		0.031*** (11.65)	0.030*** (12.69)	0.021*** (8.57)
Mean R-Squared	0.096	0.098	0.128	0.166

Table 2. Regression Estimates to Examine Momentum Effects

This table reports regression estimates for gross stock returns. The Fama-MacBeth regressions are estimated monthly, and we report the average of these coefficients. The dependent variable is monthly returns. Regarding the independent variables, the holding period for both returns and growth rates is on a half-year basis. The gross stock return is the monthly total return for the firm from CRSP. The asset growth rate (AGrowth) is defined as the six-month growth in total assets from the quarterly Compustat file. Market cap is defined as the market value of equity as of the quarter before we measure the dependent variable divided by 1000. The book-to-market ratio is as of the fiscal quarter before we measure the dependent variable. To control for outlier effects in the regression, all variables except returns are log transformed, and all independent variables are winsorized at the 0.5% and 99.5% levels. Because the asset growth rate can take non-positive values, we add one to this variable before taking the log. The Past Month Return is defined as the monthly return for the month prior to the fiscal quarter before we measure the dependent variable. The variable timings vary, and we include in parentheses the timings in relation to the dependent variable in half-years, such that -1 is the half-year before the dependent variable and +1 is the half-year contemporaneous to the dependent variable. A slight adjustment is made for Ret(-1) to exclude Past Month Return so that Ret(-1) is defined as cumulative gross return for months -6 to -2. In Panel B we include various dummy variables indicating the top and bottom quintiles of asset growth and returns. The standard errors are adjusted for serial correlation, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

Table 2 (Continued)

Panel A. Continuous Variables

	Unweighted			Weighted	
	(1)	(2)	(3)	(4)	(5)
Intercept	0.010**	0.013***	0.008*	0.009*	0.005
	(2.10)	(2.66)	(1.79)	(1.82)	(0.95)
Book-to-market ratio	0.005***	0.007***	0.007***	0.004***	0.003***
	(4.77)	(6.60)	(7.65)	(4.23)	(2.70)
Market cap	0.000	-0.000	0.000	0.000	0.000
	(0.09)	(-0.13)	(0.42)	(0.21)	(0.88)
Past Month Return	-0.039***		-0.057***	-0.035***	-0.034***
	(-6.75)		(-10.02)	(-6.02)	(-4.65)
Ret(-1)	0.006*		-0.004	0.005	-0.007
	(1.74)		(-1.03)	(1.23)	(-1.53)
Ret(-2)	0.007***		0.002	0.007**	0.004
	(2.73)		(0.73)	(2.52)	(1.06)
AGrowth(+1)		0.078***	0.081***		0.050***
		(21.96)	(23.36)		(14.88)
AGrowth(-1)		0.018***	0.019***		0.009**
		(5.13)	(6.54)		(2.53)
AGrowth(-2)		-0.015***	-0.017***		-0.010***
		(-7.48)	(-9.19)		(-3.26)
AGrowth(-3)		-0.011***	-0.012***		-0.010***
		(-5.32)	(-6.47)		(-3.93)
AGrowth(-4)		-0.008***	-0.009***		-0.007**
		(-4.20)	(-4.70)		(-2.51)
Mean R-Squared	0.046	0.047	0.068	0.052	0.133

Table 2 (Continued)

Panel B. Indicator Variables

	Unweighted			Weighted	
	(1)	(2)	(3)	(4)	(5)
Intercept	0.013***	0.013***	0.013***	0.012***	0.007
	(2.98)	(3.02)	(3.04)	(2.63)	(1.32)
Book-to-market ratio	0.005***	0.007***	0.007***	0.004***	0.003***
	(4.26)	(7.22)	(7.28)	(3.80)	(2.88)
Market cap	-0.000	-0.000	-0.000	-0.000	0.000
	(-0.38)	(-0.20)	(-0.22)	(-0.23)	(0.83)
Past Month Return	-0.038***	-0.052***	-0.052***	-0.034***	-0.030***
	(-6.73)	(-9.17)	(-9.22)	(-5.96)	(-3.91)
D(Ret(-1)=High)	0.006***	0.004***	0.002	0.005***	-0.002
	(4.85)	(3.28)	(1.37)	(3.99)	(-0.83)
D(Ret(-1)=Low)	-0.006***	-0.003*	-0.001	-0.005***	0.002
	(-3.37)	(-1.71)	(-0.51)	(-3.06)	(1.11)
D(Ret(-2)=High)	0.004***	0.002*	0.000	0.004***	0.000
	(3.03)	(1.91)	(0.20)	(2.75)	(0.09)
D(Ret(-2)=Low)	-0.005***	-0.003**	-0.002	-0.005***	-0.000
	(-3.23)	(-2.16)	(-1.17)	(-3.11)	(-0.26)
D(AGrowth(+1)=High)		0.020***	0.016***		0.007***
		(14.8)	(13.81)		(6.84)
D(AGrowth(+1)=Low)		-0.019***	-0.016***		-0.009***
		(-14.19)	(-13.99)		(-7.66)
D(Ret(-1)=High) x D(AGrowth(+1)=High)			0.009***		0.011***
			(5.89)		(4.58)
D(Ret(-1)=Low) x D(AGrowth(+1)=Low)			-0.007***		-0.012***
			(-4.55)		(-5.07)
D(Ret(-2)=High) x D(AGrowth(+1)=High)			0.007***		0.009***
			(4.89)		(4.16)
D(Ret(-2)=Low) x D(AGrowth(+1)=Low)			-0.005***		-0.006**
			(-4.02)		(-2.58)
Mean R-Squared	0.047	0.061	0.064	0.053	0.125

Table 3. Regression Estimates to Examine Cross-sectional Effects in Momentum

This table reports regressions estimates for gross stock returns and asset growth rates. The holding period for both returns and growth rates is on a half-year basis where the half hear is measured from January to June and from July to December. The gross stock return is the cumulative monthly total return for the firm from CRSP. Fama-MacBeth cross-sectional regressions are estimated every half year and the mean coefficient estimates are reported. The asset growth rate (AGrowth) is defined as the six-month growth in total assets from the quarterly Compustat file. The various dummy variables indicating the top and bottom quintiles of asset growth and returns. Market cap is defined as the market value of equity as of the quarter before we measure the dependent variable divided by 1000. The book-to-market ratio as of the fiscal quarter before we measure the dependent variable. To control for outlier effects in the regression, all variables except returns are log transformed and all variables are winsorized at the 0.5% and 99.5% levels. Because the asset growth rate can take non-positive values, we add one to this variable before taking the log. The variable timings vary, and we include in parentheses the timings in relation to the dependent variable in half-years, such that -1 is the half-year before the dependent variable and +1 is the half-year contemporaneous to the dependent variable. The High Turnover Only sample contains firms in the top turnover tercile, where turnover is defined as the past 6-month average of monthly volume scaled by shares outstanding. The Non-Investment Grade Only sample is defined as firms with an S&P firm rating below BBB-, or that have no credit rating. The No Analyst Coverage Only sample is defined as those firms that do not have analyst coverage on IBES during the month prior to the holding period. The standard errors are adjusted for serial correlation, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

Table 3 (Continued).

	Full Sample		High Turnover Only		Non-Investment Grade Only		No Analyst Coverage Only	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.082***	0.089***	0.088***	0.093***	0.041	0.053**	0.077***	0.091***
	(3.74)	(4.36)	(3.54)	(3.91)	(1.6)	(2.25)	(3.44)	(4.43)
Book-to-market ratio(-1)	0.017***	0.029***	0.009	0.023***	0.018**	0.035***	0.019***	0.031***
	(2.78)	(4.88)	(1.47)	(3.78)	(2.62)	(5.25)	(2.99)	(5.11)
Market cap(-1)	-0.000	-0.000	-0.002	-0.001	0.005	0.005	0.001	-0.001
	(-0.12)	(-0.19)	(-0.59)	(-0.46)	(1.54)	(1.42)	(0.27)	(-0.23)
AGrowth(-2)	-0.054***	-0.103***	-0.071***	-0.126***	-0.069***	-0.120***	-0.054***	-0.103***
	(-4.42)	(-8.87)	(-5.71)	(-9.35)	(-4.73)	(-9.19)	(-4.50)	(-9.09)
D(Ret(-1)=High)	0.025***	0.003	0.022***	0.002	0.029***	0.001	0.027***	0.006
	(3.84)	(0.60)	(3.14)	(0.30)	(3.43)	(0.17)	(4.43)	(1.15)
D(Ret(-1)=Low)	-0.035***	-0.011*	-0.029***	-0.004	-0.037***	-0.010	-0.037***	-0.013*
	(-4.06)	(-1.71)	(-3.53)	(-0.61)	(-5.03)	(-1.51)	(-4.08)	(-1.79)
D(AGrowth(+1)=High)		0.084***		0.084***		0.095***		0.091***
		(13.22)		(13.66)		(10.13)		(12.62)
D(AGrowth(+1)=Low)		-0.085***		-0.082***		-0.095***		-0.091***
		(-12.86)		(-11.73)		(-10.36)		(-12.5)
D(Ret(-1)=High) * D(AGrowth(+1)=High)		0.037***		0.032***		0.039***		0.034***
		(4.38)		(3.66)		(3.25)		(3.83)
D(Ret(-1)=Low) * D(AGrowth(+1)=Low)		-0.031***		-0.039***		-0.032***		-0.027***
		(-4.81)		(-5.75)		(-4.00)		(-4.11)
Mean R-Squared	0.052	0.092	0.061	0.102	0.056	0.108	0.050	0.093

Table 4. Regression Estimates to Examine Reversal Effects

This table reports regressions estimates for gross stock returns and asset growth. The holding period for both returns and growth rates is on a half-year basis where the half hear is measured from January to June and from July to December. The gross stock return is the cumulative monthly total return for the firm from CRSP. Fama-MacBeth cross-sectional regressions are estimated every half year and the mean coefficient estimates are reported. The asset growth rate (AGrowth) is defined as the six-month growth in total assets from the quarterly Compustat file. Market cap is defined as the market value of equity as of the quarter before we measure the dependent variable divided by 1000. The book-to-market ratio as of the fiscal quarter before we measure the dependent variable. To control for outlier effects in the regression, all variables except returns are all log transformed and all variables are winsorized at the 0.5% and 99.5% levels. We include various dummy variables indicating the top and bottom quintiles of asset growth and returns. The variable timings vary, and we include in parentheses the timings in relation to the dependent variable in half-years, such that -1 is the half-year before the dependent variable and +1 is the half-year contemporaneous to the dependent variable. The standard errors are adjusted for serial correlation, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

Table 4 (Continued).

	(1)	(2)	(3)	(4)
Intercept	0.076***	0.082***	0.081***	0.084***
	(3.32)	(3.61)	(3.54)	(3.75)
Book-to-market ratio(-1)	0.013*	0.010	0.011*	0.009
	(1.92)	(1.59)	(1.76)	(1.50)
Market cap(-1)	-0.000	-0.001	-0.001	-0.001
	(-0.11)	(-0.27)	(-0.27)	(-0.35)
D(Ret(-3)=High)	-0.016***	-0.011**	-0.009*	-0.006
	(-3.02)	(-2.29)	(-1.96)	(-1.41)
D(Ret(-3)=Low)	0.005	0.004	0.005	0.004
	(0.99)	(0.94)	(1.00)	(0.89)
D(AGrowth(-2)=High)		-0.024***		-0.022***
		(-4.49)		(-4.13)
D(AGrowth(-2)=Low)		-0.004		-0.002
		(-1.17)		(-0.69)
D(Ret(-3)=High) * D(AGrowth(-2)=High)		-0.006		-0.003
		(-1.34)		(-0.56)
D(Ret(-3)=Low) * D(AGrowth(-2)=Low)		0.004		0.004
		(0.78)		(0.64)
D(AGrowth(-3)=High)			-0.018***	-0.016***
			(-3.56)	(-3.38)
D(AGrowth(-3)=Low)			-0.002	-0.001
			(-0.57)	(-0.23)
D(Ret(-3)=High) * D(AGrowth(-3)=High)			-0.016***	-0.014**
			(-2.90)	(-2.47)
D(Ret(-3)=Low) * D(AGrowth(-3)=Low)			0.001	0.000
			(0.12)	(0.00)
Mean R-squared	0.042	0.047	0.048	0.052

Table 5. Portfolio returns based on past returns

This table reports monthly portfolio returns and respective asset growth rates. The portfolios are formed based on 6-month lagged returns and held for 6 months. The timing is expressed in 6 month periods, and half-year -1 refers to half year before the holding period, and half-year +1 is the holding period. In panel A portfolios are sorted on the 6-month returns prior the holding period; in panel B portfolios are sorted on the 6-month returns 6 months ago; and in panel C portfolios are sorted on the 6-month returns 12 months ago. The stocks are grouped in quintiles, and the last column contains portfolios returns for a portfolio that is long on the highest return quintile and short on lowest return quintile. We present mean gross portfolios returns, the intercepts of a 3-factor Fama and French model and the 6-month asset growth rate for the firms in the portfolio. T-statistics are in parentheses, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

Panel A. Sorted by gross returns for half-year -1

	Low returns	2	3	4	High returns	High - Low
Mean monthly gross returns for half-year +1	0.0063	0.0103	0.0117	0.0123	0.0152	0.0089*** (3.49)
Mean monthly FF-abnormal returns for half-year +1	-0.0070*** (-3.39)	-0.0018* (-1.86)	0.0000 (-0.01)	0.0007 (1.42)	0.0032*** (3.96)	0.0103*** (3.98)
Mean asset growth for half-year +1	0.0112	0.0301	0.0362	0.0449	0.0718	0.0606*** (44.05)

Panel B. Sorted by gross returns for half-year -2

	Low returns	2	3	4	High returns	High - Low
Mean monthly gross returns for half-year +1	0.0091	0.0115	0.0121	0.0128	0.0123	0.0032** (2.08)
Mean monthly FF-abnormal returns for half-year +1	-0.0043*** (-3.42)	-0.0008 (1.15)	0.0004 (0.74)	0.0013** (2.01)	0.0001 (0.15)	0.0044*** (3.03)
Mean asset growth for half-year -1	0.0226	0.0329	0.0382	0.0472	0.0752	0.0526*** (41.78)

Panel C. Sorted by gross returns for half year -3

	Low returns	2	3	4	High returns	High - Low
Mean monthly gross returns for half-year +1	0.0134	0.0126	0.0123	0.0115	0.0090	-0.0043*** (-3.45)
Mean monthly FF-abnormal returns for half-year +1	-0.0001 (-0.10)	0.0004 (0.57)	0.0006 (1.07)	-0.0001 (-0.12)	-0.0030*** (-3.16)	-0.0029** (-2.51)
Mean asset growth for half-year -1	0.0254	0.0330	0.0374	0.0450	0.0666	0.0412*** (44.77)

Table 6. Portfolio returns with asset growth interaction

This table reports monthly portfolio returns for momentum (panel A) and reversal (panel B) effects. The returns are adjusted based on the Fama-French three-factor model. The timing is expressed in 6 month periods, such that half-year -1 refers to half-year before the holding period, and half-year +1 is the holding period. Portfolios are independently sorted on two-way quintiles: the 6 month asset growth contemporaneous to the holding period (half-year +1) and the 6-month returns prior to the holding period (half-year -1) (Panel A) and the 6-month returns 1-year before the holding period (half-year -3), and the subsequent asset growth (half-year -2) (Panel B). The last column contains portfolios returns for a portfolio that is long on the highest return quintile and short on lowest return quintile. T-statistics are in parentheses, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

Panel A. Abnormal returns for momentum portfolios

		Sorted by gross returns for half-year -1					
		Low returns	2	3	4	High returns	High – Low
Sorted by asset growth for half-year +1	Low Growth	-0.0205***	-0.0145***	-0.0120***	-0.0112***	-0.0126***	0.0079***
		(-8.01)	(-11.88)	(-14.40)	(-15.52)	(-13.02)	(2.91)
	2	-0.0056***	-0.0042***	-0.0032***	-0.0035***	-0.0058***	-0.0002
		(-2.87)	(-4.13)	(-4.79)	(-5.77)	(-7.54)	(-0.11)
	3	-0.0014	0.0000	0.0007	-0.0003	-0.0018**	-0.0004
		(-0.79)	(0.03)	(1.06)	(-0.50)	(-2.13)	(-0.18)
	4	0.0014	0.0031***	0.0038***	0.0039***	0.0054***	0.0040*
		(0.75)	(3.32)	(5.39)	(6.07)	(5.65)	(1.67)
	High Growth	0.0039**	0.0060***	0.0067***	0.0082***	0.0130***	0.0091***
		(2.22)	(6.20)	(9.29)	(11.43)	(11.29)	(3.81)

Panel B. Abnormal returns for reversal portfolios

		Sorted by gross returns for half-year -3					
		Low returns	2	3	4	High returns	High - Low
Sorted by asset growth for half-year -2	Low Growth	0.0005	0.0010	0.0014**	0.0007	-0.0020*	-0.0025*
		(0.38)	(1.40)	(2.26)	(1.00)	(-1.80)	(-1.91)
	2	0.0012	0.0013**	0.0016***	0.0017***	-0.0007	-0.0019
		(1.17)	(2.05)	(2.75)	(2.58)	(-0.70)	(-1.52)
	3	0.0009	0.0015**	0.0015***	0.0009	-0.0006	-0.0015
		(0.88)	(2.25)	(2.59)	(1.37)	(-0.59)	(-1.20)
	4	0.0001	0.0001	0.0004	0.0000	-0.0012	-0.0012
		(0.07)	(0.14)	(0.61)	(0.06)	(-1.15)	(-0.97)
	High Growth	-0.0047***	-0.0039***	-0.0037***	-0.0042***	-0.0071***	-0.0025**
		(-3.18)	(-4.16)	(-4.21)	(-4.36)	(-6.04)	(-1.98)

Table 7. Momentum portfolio returns with predicted investment interaction

This table reports monthly portfolio returns. The returns are adjusted based on the Fama-French three-factor model. The timing is expressed in 6 month periods, such that half-year -1 refers to half-year before the holding period, and half-year +1 is the holding period. Portfolios are independently sorted on two-way quintiles: the 6-month returns prior to the holding period, and the predicted 6 month asset growth contemporaneous to the holding period. Asset growth is predicted using a regression of asset growth during half year +1 on book to market, 4 lags of asset growth and 4 lags of 6 month returns (similar to regression 3 in Panel B of Table 1 except that the contemporaneous return is not included). The last column contains portfolios returns for a portfolio that is long on the highest return quintile and short on lowest return quintile. T-statistics are in parentheses, and *** denote significance at the 1% level, ** at the 5% level and * at the 10% level.

		Sorted by gross returns for half-year -1					
		Low returns	2	3	4	High returns	High – Low
Sorted by predicted asset growth for half-year +1	Low Growth	-0.0042*	-0.0013	-0.0013	-0.0002	-0.0004	0.0038
		(-1.73)	(-1.13)	(-1.45)	(-0.21)	(-0.27)	(1.30)
	2	-0.0034	0.0003	0.0015**	0.0005	0.0005	0.0039
		(-1.60)	(0.25)	(2.06)	(0.62)	(0.41)	(1.57)
	3	-0.0031	0.0003	0.0012*	0.0014**	0.0010	0.0042*
		(-1.50)	(0.34)	(1.74)	(2.01)	(1.16)	(1.72)
	4	-0.0063***	-0.0014	0.0011	0.0016**	0.0029***	0.0093***
		(-3.23)	(-1.21)	(1.44)	(2.18)	(3.20)	(3.86)
	High Growth	-0.0122***	-0.0051***	-0.0013	0.0014*	0.0046***	0.0167***
		(-5.33)	(-4.53)	(-1.45)	(1.84)	(4.11)	(6.14)

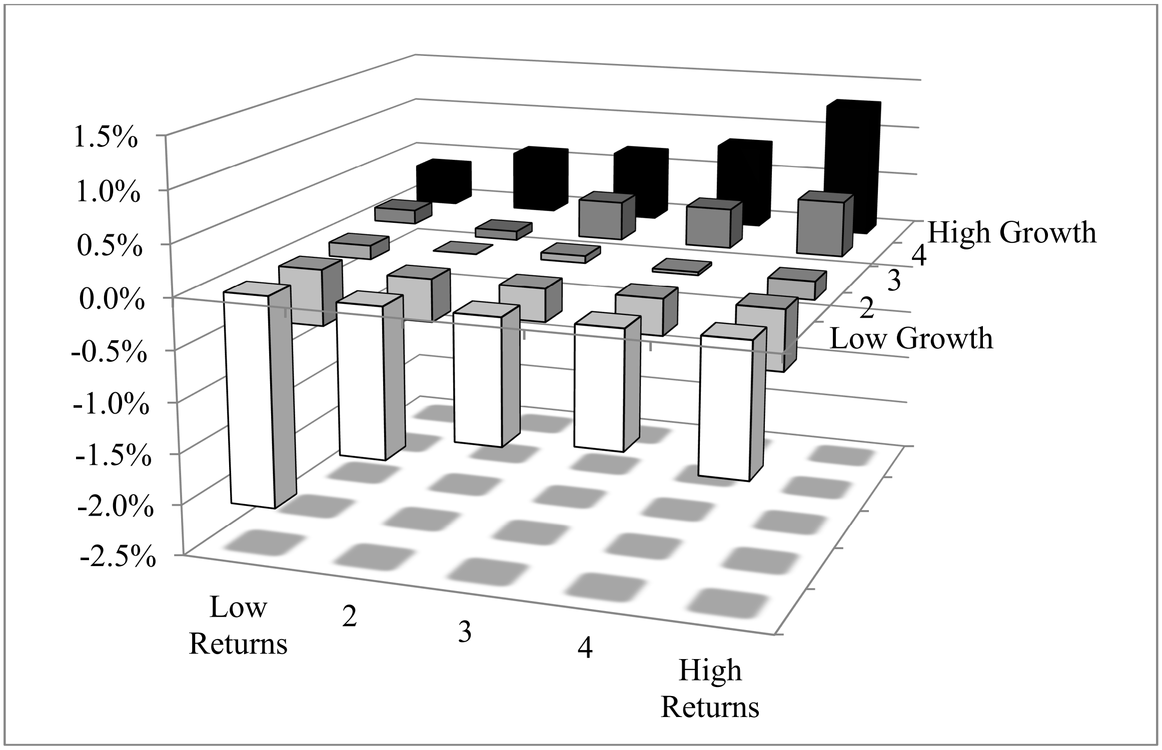
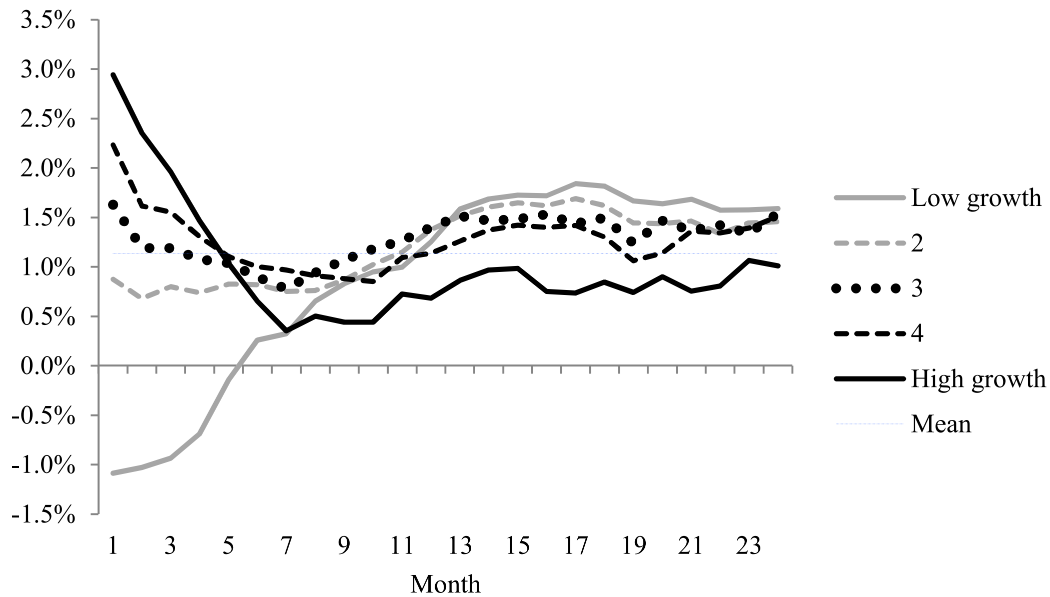
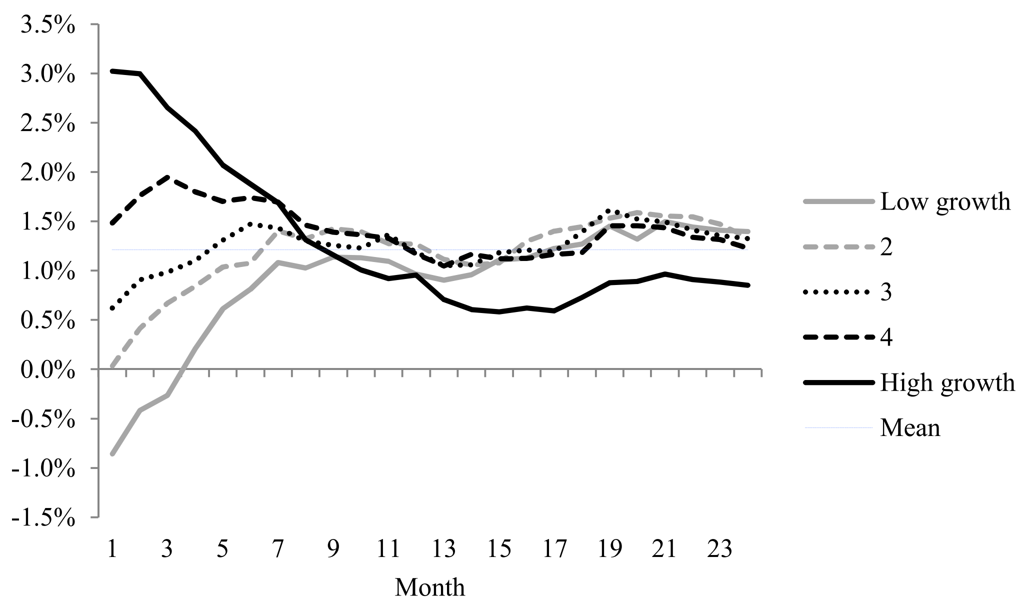


Figure 1. Momentum portfolio returns by asset growth quintiles. This figure plots monthly portfolio returns over a half-year holding period. The returns are adjusted based on the Fama-French three-factor model. Portfolios are independently sorted on two-way quintiles: the 6-month returns prior to the holding period and the 6-month asset growth contemporaneous to the holding period.



Panel A. High returns (t-1)



Panel B. Low returns (t-1)

Figure 2. Portfolio returns by month relative to sorting period. Portfolios are independently sorted on 6-month asset growth quintiles in period +1 and 6-month return quintiles in period -1. Panel A plots monthly portfolio returns relative to sorting period for asset growth portfolios in the top quintile of 6-month returns, while Panel B plots portfolio returns for the asset growth portfolios in the bottom quintile of 6-month returns. The mean is the overall mean of the 5 growth portfolios across the 24-month period.