Momentum Pattern of the Growth Anomaly

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This paper investigates if the growth anomaly, the phenomenon that stocks of firms with lower growth in capital investment expenditures have higher future returns, exhibits the momentum pattern and if it can be explained from behavioral perspectives. We achieve this by decomposing a long-term 3-year investment growth into three consecutive short-term growth measures. The result from a cross-sectional analysis indeed reveals the presence of the momentum pattern in the growth anomaly that can be explained by behavioral theories. Long-term 3-year investment growth is statistically significant in explaining subsequent stock returns, but the first 1-year growth that is closest to the formation affects the returns (and hence is priced by investors) the most, followed by the second and third ones, monotonically. A further investigation shows that the growth anomaly is amplified by limits to arbitrage as measured by the level of idiosyncratic risk. However, the farther growth is less sensitive to the limit-to-arbitrage measure, thereby reiterating the momentum pattern of the growth anomaly.

Keywords: growth anomaly, momentum effect, behavioral finance, mispricing theory, limits to arbitrage, idiosyncratic risk

INTRODUCTION

Recent literature in asset pricing has documented the growth anomaly in which the growth of firms' assets or capital investment expenditures is negatively related to future stock returns, thereby resulting in the return premium between low and high growth firms. Fama and French (2006) show a significant negative relation between the asset growth and subsequent stock returns based on the valuation theory. Titman, Wei and Xie (2004) indicate that the investment growth anomaly occurs because investors underreact to the management's empire building behavior of increased capital expenditures, thereby resulting lower returns for firm with higher investment growth. Anderson and Garcia-Feijoó (2006) suggest the investment growth is the proxy for the exercise of real investment options in theoretical models. Cooper, Gulen, and Schill (2008) document that the asset growth is statistically significant in explaining stock returns even after controlling for book-to-market ratios, firm capitalization, prior returns, accruals, and other growth measures. Titman, Wei and Xie (2012) also find that the growth effect is stronger in countries with more developed financial markets. Zhang (2005), Xing (2008), and Liu, Whited and Zhang (2009) propose an explanation for the anomaly based on the q-theory of investments developed by Cochrane (1991, 1996). The theory predicts that firms tend to invest less when the cost of capital is high and invest more when the cost of capital is low. This corporate decision produces the negative investment-return relationship. In this paper, we extend prior literature by investigating if the growth anomaly shows the momentum pattern, and if so, whether the anomaly can be related to behavioral theories or explanations.

The momentum pattern in stock returns is evident when stocks with previously high or low prior returns continue to perform well or poorly, respectively, as evidenced and explained in Carhart (1997). Novy-Marx (2012) finds that stock returns are largely driven by firms' performance during twelve to seven months, not six to two months, prior to portfolio formation, thereby contradicting the notion of the momentum effect that the latest prior return should affect the current return the most. This investigation begs the question if the momentum pattern can occur in other asset pricing anomalies as well. The growth anomaly is an excellent candidate for an empirical investigation. Unlike other variables in asset pricing literature (e.g., size, book-to-market, liquidity, or profitability), the investment growth measures the change in the variable (i.e., capital investments) from one point in time to another. Hence, the investment growth can be decomposed into earlier and later consecutive periods or components (in a similar fashion to the term structure of interest rates) and enables us to analyze how these components may affect returns differently. With the decomposition of the investment growth into short-term consecutive growth which has not been done in prior studies, this paper can provide greater insights into the growth anomaly including its pattern and potential explanations.

Behavioral explanations for the growth anomaly are based on the growth-oriented investing hypothesis by Lakonishok, Vishny, and Shleifer (1994). Cooper, Gulen, and Schill (2008) explain the anomaly as the overreaction of investors to changes in companies' growth prospects proxied by asset expansions. Consistent with the mispricing theory, investors make systematic errors in forecasts and "misprice" high versus low growth firms by overvaluing high growth firms and undervaluing low growth ones. Afterwards, the mispricing is realized and stock prices are corrected. Consequently, high growth firms have low stock returns while low growth firms have high stock returns, thereby a negative relationship. Lam and Wei (2013) show that a negative relationship between asset growth and future stock returns mainly comes from high- and low-growth firms that reverse their prospect in the future. Consistent with the limit-to-arbitrage theory, Lipson, Mortal, and Schill (2011) show that the growth anomaly is more pronounced when arbitrages are more limited. Specifically, the interaction term between an asset growth variable and the limit-to-arbitrage variable (represented by the level of idiosyncratic risk or volatility) is significant in explaining stock returns. Further, the limits to arbitrage can be asymmetric. Consistent with the arbitrage asymmetry theory, Stambaugh, Yu, and Yuan (2015) propose that high idiosyncratic volatility prevents arbitrageurs from exploiting a short position on overpriced stocks more than a long position on underpriced stocks. Additionally, our decomposition of the long-term investment growth into three consecutive short-term growth measures can help to reveal if investors are myopic. Consistent with the myopic theory, investors tend to put too much weight on the most recent information (Kahneman and Tversky, 1974). Thus, if this is the case, our result should show that the most recent growth affects the return more significantly than does the farther growth.

In sum, we expand an investigation into the growth anomaly in the existing literature by decomposing a long-term 3-year investment growth measure into three consecutive short-term 1-year growth measures based on the concept of term structure. With this decomposition, we test if the growth anomaly exhibits the momentum pattern. Further, our investigation can show if the above behavioral theories (mispricing, myopic, limit-to-arbitrage, and arbitrage asymmetry) are consistent with empirical evidence. Prior studies have not decomposed long-term growth measures into short-term components and related the growth anomaly to those behavioral theories concurrently.

We find, based on cross-sectional regressions, that the explanatory power of the 3-year long-term investment growth (IG13) on stock returns is statistically significant and comes from its most recent 1-year growth component (IG1, one year closest to the formation period). The farther 1-year growth components (IG2 and IG3; two and three years away from the formation period, respectively) show monotonically diminishing explanatory power and lesser negative effects on the returns. These results show the momentum pattern of the growth anomaly which indicates short memory of investors and is consistent with the myopic theory from behavioral perspectives. Combining the myopic theory with the mispricing theory, investors use more recent information (as opposed to less recent information) to extrapolate too much into the future about firms' prospects and misprice high and low growth firms. We confirm this conclusion by performing a portfolio analysis. Evidence of more severe mispricing and hence higher return premium indeed exists closer to the portfolio formation year than farther distant years.

Additionally, the growth decomposition allows us to gain more insights into the limit-to-arbitrage and arbitrage asymmetry theories. Regarding the limit-to-arbitrage theory, we find that the idiosyncratic risk, which reflects the degree of limits to arbitrage, affects more on recent growth components than on farther growth components due to myopic mispricing. Consistent with the arbitrage asymmetry theory, we empirically confirm that, with the same level of an increase in idiosyncratic risk, the benchmark-adjusted return premium on the long position is lower than the benchmark-adjusted return discount on the short position. The asymmetry is less when farther growth is considered. Taken together, the growth anomaly indeed shows the momentum pattern and can be contemporaneously explained by the mispricing, myopic, limit-to-arbitrage and arbitrage asymmetry theories.

Our results and conclusions have useful implications for policymakers and investors. Realizing the myopic nature of investors, the policymakers can encourage firms to provide and emphasize the use of information about their long-term growth as opposed to short-term growth. This should help to lessen the degree of incorrect extrapolation, mispricing, arbitrage asymmetry and inefficiency by investors based on short-term information.

VARIABLE DEFINITIONS, SAMPLE SELECTION PROCEDURES, AND METHODOLOGIES

Following common practice in asset pricing literature, we match stock returns for the period July of year t to June of year t + 1 to the annual accounting data in Compustat annual file for the fiscal year ending in calendar year t – 1. All characteristic variables in this study are updated annually except the momentum which is updated monthly. The 3-year growth (IG13) is the rate of growth of capital expenditures at the fiscal year ending in calendar year t−1 relative to the fiscal year ending in calendar year t−4. The first 1-year growth (IG1) is the rate of growth of capital expenditures at the fiscal year ending in calendar year t−1 relative to the fiscal year ending in calendar year t−2. The second 1-year growth (IG2) is the rate of growth of capital expenditures at the fiscal year ending in calendar year t−2 relative to the fiscal year ending in calendar year t−3. The third 1-year growth (IG3) is the rate of growth of capital expenditures at the fiscal year ending in calendar year t−3 relative to the fiscal year ending in calendar year t−4. All growth measures then are matched with stock returns for the period July of year t to June of year t+1.

Other variables are as follows. Firm size (SIZE) is the price multiplied by shares outstanding at the end of June of year t. Book-to-market equity ratio (BEME) is the ratio of book equity for the fiscal year ending in calendar t−1 to market equity at the end of December in calendar year t−1. Book equity is the difference between assets (item AT) and liability (item LT) plus balance sheet deferred taxes (item TXDB if available) minus the book value of preferred stock. Depending on data availability, we use liquidation (item PSTKL), redemption (item PSTKRV), or preferred stock at carrying value (item UPSTK), in this order, to represent the book value of preferred stock. Prior one-year stock return (MOM) is the compounded monthly raw stock return, skipping the latest month, over the previous year. Idiosyncratic stock return volatility (IVOL) is the standard deviation of the residual values from a time-series market model. The model is estimated with 36 months of returns (requiring a full 36- month history) ending in June of year t. Operating profit margin (OPM) is calculated from operating income before depreciation (item OIBDQ) for the fiscal year ending in calendar t−1 divided by sales (item SALE) for the fiscal year ending in calendar t−1.

The dataset used in this study involves U.S. firms traded on the NYSE, Amex, and NASDAQ exchanges. Financial statement items above are taken from Compustat. Stock market data come from the Center for Research in Security Prices (CRSP). Our sample period spans from July 1954 until the most recent month at data collection. Similar to Fama and French (1992, 1993), certificates, American depositary receipts (ADRs), shares of beneficial interest (SBIs), unit trusts, closed-end funds, real estate investment trusts (REITs), and financial firms are excluded. Following Titman, Wei, and Xie (2004), we remove firms with less than $10 million in sales (Compustat item REVT) to exclude firms at an early stage of developments. We also delete firms for which we do not have all the data necessary to compute the variables. All tests require each firm to have all variables in this study. We mitigate survivorship and selection biases by requiring firms to have at least two years of Compustat data. Proper adjustments for delisted firms are used as suggested by Shumway (1997). Fama-French (1993) and Carhart (1997) factors, market risk premiums, and risk-free rates are obtained from Kenneth French's Data Library.

SAMPLE CHARACTERISTICS

Panel A of Table 1 reports means for the sample. Column "All" which includes all observations indicates that the long-term 3-year growth (IG13) has the mean of 1.1674. In terms of one-year growth measures, the farthest one-year growth component (IG3) has the highest mean of 0.4308 while the nearest one (IG1) has the lowest mean of 0.3713. IG3 has the spread of 2.2390 - (-0.4932) = 2.7323 and IG1 has the spread of 2.0305 - (-0.5003) = 2.5308.

Table 1 also shows that high investment growth stocks (irrespective of IG13, IG3, IG2 or IG1 measures) have large size (SIZE), low book-to-market ratio (BEME), low momentum (MOM), low idiosyncratic volatility (IVOL), and high profitability (OPM). For example, the high long-term 3-year growth (HIG13, with the mean of 5.3003) is associated with larger SIZE, lower BEME, lower MOM, lower IVOL and higher OPM compared to the low long-term 3-year growth (LIG13, with the mean of -0.5535). The correlation matrix in Panel C indicates that the three 1-year growth measures are not quite related. Correlations between IG1 and IG2, IG1 and IG3, IG2 and IG3 are -0.0102, -0.0025, and -0.0012, respectively.

CROSS-SECTIONAL FIRM-LEVEL REGRESSION TESTS

Table 2 shows results from cross-sectional regressions of monthly returns on investment growth measures with and without control variables (i.e., under multivariate and univariate specifications). The results show that long-term 3-year growth (IG13) is statistically significant in explaining subsequent stock returns. IG13 induces the returns by the slope of -0.1381 (t=-5.25) and -0.0763 (t=-3.48) under univariate and multivariate specifications, respectively. Further, it is formative to ask which 1-year growth induces returns the most, given the finding from Table 1 that IG3 is the largest one-year growth component due to its largest mean relative to IG2 and IG1. Interestingly, the results in Table 2 reveal that IG3 does not have the steepest cross-sectional slope. The most recent 1-year growth (IG1, closest to the formation period) has the highest slope and thus strongest effects on returns. The farther 1-year growth measures (IG2 and IG3, two and three years away from the formation period) show monotonically diminishing effects in both univariate and multivariate regressions. Specifically, IG1, IG2 and IG3 induce the returns by the slopes of -0.1823 (t = -6.03), -0.0644 (t = -2.28), and -0.0232 (t = -0.87) in univariate regressions, respectively; and by the slopes of -0.1170 (t = -4.59), -0.0332 (t = -1.35), and 0.0039 (t = 0.15) in multivariate regressions, respectively.

Differences between IG1 and IG3 slopes are -0.1590 (t = -3.80) in a univariate regression and -0.1210 (t = -3.14) in a multivariate regression. Hence, IG1 slopes are statistically steeper than IG3 slopes. Further, differences between IG1 and IG13 slopes are -0.0442 (t = -1.73) in a univariate regression and -0.0407 (t = -1.69) in a multivariate regression. This suggests that IG1 slopes are statistically steeper than IG13 only at a 10% level, but not at a 5% or 1% level. Therefore, the effect of the most recent one-year growth (IG1) is comparable to, or marginally above, that of the 3-year growth (IG13). These results, together, confirm that stock returns are affected by (or investors price) the nearest growth the most even though the nearest growth is the smallest and that the long-term growth effect is mainly from the most recent short-term growth component. Hence, the growth anomaly indeed shows the momentum pattern. The anomaly also is consistent with the mispricing and myopic theories in that there exists a strong negative relationship between the investment growth and stock returns and that the more severe mispricing exists closer to the portfolio formation year than farther distant years due to the myopic nature (or shortsightedness) of investors.

PORTFOLIO PERFORMANCE

As documented by prior studies, high growth portfolios generally have lower returns than low growth counterparts as indicated by spreads from low-minus-high hedge portfolios. To confirm the mispricing and myopic theories, a steeper cross-sectional slope (in Table 2) should be aligned with the result of a higher return spread or abnormal return (alpha) spread at a portfolio level.

Table 3 shows performance of growth-sorted portfolios with 5 categories of portfolio excess returns and abnormal returns (alphas). Panel A presents value-weighted and equally-weighted portfolio excess returns sorted by deciles of IG13, IG1, IG2, and IG3. Panel B presents value-weighted portfolio abnormal returns (alphas) sorted by deciles of IG13, IG1, IG2, and IG3. Alphas are computed using the Capital Asset Pricing model (CAPM), Fama-French (1993) model (FF), and Fama-French-Carhart (1997) model (FFC).

The results from Panel A indicate that the spreads based on equally-weighted returns are more pronounced than value-weighted ones. The value-weighted (VW) and equally-weighted (EW) return spreads show that IG1 has a slightly higher return spread than IG13. The VW and EW spreads of IG1 are 0.360% and 0.480% while those of IG13 are 0.312% and 0.420%, respectively. The VW and EW spreads of IG1 are also higher than those of IG3 (0.071% and 0.030%, respectively). The results in Panel B show similar patterns. The alpha spreads of IG1 are higher than those of IG3 irrespective of the models employed. The CAPM, FF and FFC alpha spreads of IG1 are 0.389%, 0.179% and 0.165% while those of IG3 are 0.142%, 0.047% and -0.006%, respectively. Therefore, short-term growth effects show a diminishing pattern from the most recent growth to the most distant one. The results are consistent with slopes from cross-sectional regressions in Table 2, thereby reiterating the momentum pattern of the growth anomaly and its consistency with the mispricing and myopic behavior of investors.

LIMIT-TO-ARBITRAGE THEORY

In this section, we investigate if the momentum pattern of the growth effect is related to the limit to arbitrage. If the limit-to-arbitrage theory is valid in explaining the growth effect, we should expect to see that the growth effect (irrespective of whether it is from long-term growth or any short-term components) is more pronounced when the limit to arbitrage as proxied by the idiosyncratic volatility or risk is high. In other words, high idiosyncratic risk should induce higher returns or alphas accordingly.

Table 4 presents performance of investment growth portfolios (IG1, IG2 and IG3) under different limit-to-arbitrage categories (high idiosyncratic volatility IVOL and low idiosyncratic volatility IVOL). In Panels A through C, the results show that higher idiosyncratic risk indeed leads to higher returns or alphas. For instance, IG1 growth portfolios with high IVOL generate higher hedge returns or alphas (L-H) than IG1 growth portfolios with low IVOL. This is true irrespective of whether the performance is measured in terms of value-weighted returns (0.635% versus 0.152%, Panel A), equally-weight returns (0.483% versus 0.190%, Panel A), CAPM alphas (0.691% versus 0.200%, Panel B), FF alphas (0.523% versus 0.047%, Panel B), and FFC alphas (0.334% versus -0.022%, Panel C). Further, IG2 and IG3 growth portfolios show less and less degree of performance differences between high and low IVOL categories. For instance, the hedge returns or alphas (L-H) for IG3 growth portfolios with high versus low IVOL are 0.123% versus 0.045% (value-weighted returns, Panel A), 0.109% versus -0.088% (equally-weighted returns, Panel A), 0.207% versus 0.123% (CAPM alphas, Panel B), 0.105% versus 0.058% (FF alphas, Panel B), and 0.126% versus 0.025% (FFC alphas, Panel C). This is because IG2 and IG3 reflect lower and lower degree of mispricing as indicated in previous tables. Therefore, performance differences appear to be smaller and smaller and eventually negligible as the hedge returns or alphas become statistically insignificant. In sum, the results in this section suggest that the growth anomaly is affected and can also be explained by the limit-to-arbitrage theory. The performance difference due to different levels of limits to arbitrage reflects the degree of mispricing associated with short-term growth measures.

ARBITRAGE ASYMMETRY THEORY

If high idiosyncratic risk causes severe mispricing thereby generating the growth effect, the arbitrage asymmetry effect should consequently take place. That is, short-leg arbitrage should be more sensitive to the change in idiosyncratic risk than long-leg arbitrage since a short position has more constraints than a long position as suggested by Stambaugh, Yu, and Yuan (2015).

Panel D of Table 4 shows that the portfolio alpha difference by longing high and shorting low idiosyncratic volatility portfolios sorted by quintiles of IG1 is greater on the short position of High IG1 than the long position of Low IG1 for CAPM and FF specifications. Specifically, the decreasing level of alpha in a short H IG1 position is negative and statistically significant (-0.415% with -2.20 t-stat for CAPM and 0.340% with -2.08 t-stat for FF) while the increasing level of alpha in a long L IG1 position is positive but not statistically significant (0.076% with 0.44 t-stat for CAPM and 0.137% with 0.95 t-stat for FF). The FFC specification seems to be a hurdle for IG1 because the alpha differences on both short and long positions are statistically insignificant. Further, since IG2 and IG3 have less degree of mispricing than IG1, the arbitrage asymmetry (along with the limit to arbitrage) becomes less evident. As shown in Panel C, the alpha differences for IG2 and IG3 are not statistically significant on both short and long legs irrespective of whether the CAPM, FF or FFC specification is used. In sum, in addition to the mispricing, myopic and limit-to-arbitrage theories, the results in Panel D show evidence that the growth anomaly can be explained by the arbitrage asymmetry theory.

CONCLUSION

This paper updates and extends prior asset pricing literature with respect to the growth anomaly, the phenomenon that stocks of firms with lower growth in capital investment expenditures have higher future returns. It is the first asset pricing study that decomposes long-term growth into short-term consecutive growth measures, examines if the growth anomaly exhibits momentum pattern (similar to the momentum effect in stock returns), and if the anomaly and its pattern can be contemporaneously explained by behavioral finance theories.

The results show that there exists the growth anomaly with the momentum pattern that can be explained contemporaneously by the mispricing, myopic, limit-to-arbitrage and arbitrage asymmetry theories. We find a negative relationship between long-term or short-term investment growth and stock returns, thereby confirming the presence of the growth anomaly. The growth anomaly shows the momentum pattern in that the most recent one-year growth affects stock returns more strongly and negatively than earlier one-year growth does. Hence, investors put more weights on pricing what happened more recently than earlier, and in the process extrapolate too much or misprice the firms’ growth prospects. This is reiterated by greater hedge return premiums generated from the most recent growth portfolios relative to earlier growth portfolios. The above results, together, strongly support the validity of the mispricing and myopic theories from behavioral perspectives. We also find support for the limit-to-arbitrage and arbitrage asymmetry theories. The idiosyncratic risk amplifies the mispricing and induces return discounts on short legs more than return premiums on long legs. The idiosyncratic risk and arbitrage asymmetry effects are lessened towards earlier one-year growth measures, thereby consistent with the momentum pattern and the myopic mispricing of investors.

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APPENDIX

TABLE 1
CHARACTERISTICS OF INVESTMENT GROWTH PORTFOLIOS

Panel A: Mean

	All	L *IG13*	H *IG13*	L *IG3*	H *IG3*	L *IG2*	H *IG2*	L *IG1*	H *IG1*
IG13	1.1674	-0.5535	5.3003	0.1513	3.5592	0.3389	3.2567	0.1623	3.3980
IG3	0.4308	-0.0790	1.4468	-0.4932	2.2390	0.9247	0.2803	0.6955	0.4209
IG2	0.3948	-0.0084	1.1448	0.9240	0.1961	-0.4998	2.1344	0.8937	0.2487
IG1	0.3713	-0.0245	1.2133	0.7334	0.3078	0.8615	0.1789	-0.5003	2.0305
SIZE	1713.02	685.65	1221.05	660.69	885.28	613.79	930.03	589.13	943.37
BEME	0.9879	1.2268	0.8691	1.0919	0.9757	1.1302	0.9662	1.1649	0.9190
MOM	0.1546	0.1820	0.1318	0.1633	0.1558	0.1732	0.1428	0.1780	0.1373
IVOL	0.0986	0.1156	0.1066	0.1120	0.1085	0.1134	0.1077	0.1126	0.1090
OPM	0.1272	0.0892	0.1336	0.1053	0.1160	0.1008	0.1197	0.0887	0.1255

Panel B: Correlation

	IG13	*IG3*	*IG2*
IG3	0.276		
	(0.00)		
IG2	0.0998	-0.012	
	(0.00)	(0.00)	
IG1	0.0803	-0.0025	-0.0102
	(0.00)	(0.41)	(0.00)

This table reports selected characteristics for three investment growth measures extreme (i.e. lowest (L) and highest (H)) quintile portfolios. 3-year growth (IG13) is the rate at fiscal year ending in calendar year t−1 relative to capital expenditures at fiscal quarter ending in calendar year t−4. First 1-year growth (IG1) is the rate at fiscal quarter ending in calendar year t−1 relative to capital expenditures at fiscal quarter ending in calendar year t−2. Second 1-year growth (IG2) is the rate at fiscal quarter ending in calendar year t−2 relative to capital expenditures at fiscal quarter ending in calendar year t−3. Third 1-year growth (IG3) is the rate at fiscal quarter ending in calendar year t−3 relative to capital expenditures at fiscal quarter ending in calendar year t−4. Panel A presents means of characteristics of investment growth portfolios. For each portfolio and in each year (except momentum), the mean is calculated across stocks. The mean shown below is the time-series average computed over all years. Momentum is done under monthly, not yearly, basis. Characteristics include the market value of equity (SIZE) (×103), book-to-market equity (BEME), momentum (MOM), idiosyncratic volatility (IVOL), and operating margin (OPM). Panel B reports pair-wise correlation coefficients. The numbers in parentheses are p-values.

TABLE 2
CROSS-SECTIONAL REGRESSIONS OF MONTHLY RETURNS ON INVESTMENT GROWTH MEASURES WITH AND WITHOUT CONTROL VARIABLES

IG13	*IG3*	*IG2*	*IG1*	*IG1-IG13*	*IG1-IG3*	*SZ*	*BM*	*MO*
Panel A: Multivariate Analysis								
-0.0763%						-0.1076%	0.1774%	0.9749%
-3.48						-3.72	3.3	5.7
	0.0039%					-0.1087%	0.1925%	0.9888%
	0.15					-3.74	3.56	5.79
		-0.0332%				-0.1094%	0.1923%	0.9869%
		-1.35				-3.78	3.54	5.78
			-0.1170%			-0.1085%	0.1804%	0.9786%
			-4.59			-3.75	3.34	5.72
				-0.0407%				
				-1.69				
					-0.1210%			
					-3.14			
Panel B: Univariate Analysis								
-0.1381%	-0.0232%	-0.0644%	-0.1823%	-0.0442%	-0.1590%	-0.1383%	0.3305%	1.0267%
-5.25	-0.87	-2.28	-6.03	-1.73	-3.8	-4.53	5.59	5.77

Panel A (B) reports the estimated multivariate (univariate) slope coefficients (b and c) in the following Fama and MacBeth (1973) cross-sectional regression:

$$R_{i,t+1} = a + b'IG_{i,t} + c'Controls_{i,t} + \epsilon_{i,t+1},$$

where Rt+1 is monthly raw return between July of year t and June of year t+1. For this table, all investment growth measures (IG) are the continuous form of the growth measures defined in Table 1. The set of control variables (Controls) includes the natural logarithm of market capitalization (SIZE), natural logarithm of book-to-market equity ratio (BEME), and 12-month continuous return prior to the holding period skipping the latest month (MOM)). All right-hand side variables are updated annually except momentum which is updated monthly. t-statistics are shown under the coefficient estimates. All coefficients are in percentage.

TABLE 3
PERFORMANCE OF INVESTMENT GROWTH PORTFOLIOS

Panel A:

	L	2	3	4	5	6	7	8	9	H	L-H
Value Weighted											
IG13	0.782%	0.732%	0.783%	0.696%	0.577%	0.634%	0.595%	0.549%	0.671%	0.470%	0.312%
	3.70	4.03	4.76	4.24	3.54	3.98	3.33	3.04	3.24	1.91	2.21
IG1	0.775%	0.685%	0.745%	0.629%	0.689%	0.591%	0.550%	0.665%	0.494%	0.415%	0.360%
	3.47	3.61	4.38	3.72	4.35	3.64	3.20	3.53	2.39	1.79	2.78
IG2	0.873%	0.603%	0.700%	0.574%	0.611%	0.587%	0.613%	0.655%	0.519%	0.565%	0.308%
	4.04	3.17	3.90	3.44	3.83	3.63	3.54	3.46	2.54	2.38	2.47
IG3	0.631%	0.651%	0.673%	0.672%	0.653%	0.560%	0.579%	0.614%	0.675%	0.560%	0.071%
	2.95	3.58	3.99	4.11	4.11	3.44	3.32	3.12	3.22	2.34	0.57
Equally Weighted											
IG13	1.186%	1.082%	1.059%	0.968%	0.968%	0.992%	0.918%	0.846%	0.866%	0.766%	0.420%
	5.02	5.27	5.43	5.12	5.22	5.27	4.70	4.25	4.07	3.27	4.59
IG1	1.208%	1.065%	1.019%	1.015%	0.951%	0.925%	0.957%	0.911%	0.867%	0.728%	0.480%
	5.21	4.97	5.13	5.31	5.13	4.95	4.92	4.54	4.16	3.25	6.51
IG2	1.095%	1.007%	1.007%	0.923%	0.961%	0.928%	0.936%	0.965%	0.869%	0.961%	0.134%
	4.81	4.76	5.08	4.81	5.16	4.90	4.81	4.81	4.13	4.27	1.92
IG3	1.006%	1.039%	0.945%	0.932%	0.975%	0.909%	0.941%	0.961%	0.968%	0.975%	0.030%
	4.59	4.98	4.86	4.99	5.21	4.79	4.76	4.68	4.55	4.20	0.44

Panel B:

	L	2	3	4	5	6	7	8	9	H	L-H
CAPM alpha											
IG13	0.125%	0.146%	0.247%	0.161%	0.044%	0.115%	0.007%	-0.035%	-0.003%	-0.297%	0.423%
	1.22	1.90	3.73	2.46	0.68	1.80	0.10	-0.47	-0.03	-2.51	3.03
IG1	0.076%	0.071%	0.190%	0.077%	0.174%	0.047%	-0.013%	0.044%	-0.179%	-0.313%	0.389%
	0.71	0.90	2.82	1.16	2.71	0.86	-0.19	0.63	-2.18	-2.86	2.99
IG2	0.197%	-0.011%	0.109%	0.026%	0.088%	0.052%	0.044%	0.038%	-0.125%	-0.185%	0.382%
	1.91	-0.14	1.61	0.41	1.41	0.88	0.66	0.50	-1.33	-1.70	3.07
IG3	-0.046%	0.060%	0.122%	0.130%	0.139%	0.017%	0.004%	-0.023%	-0.008%	-0.188%	0.142%
	-0.48	0.82	1.82	2.18	2.11	0.30	0.07	-0.28	-0.10	-1.65	1.16
FF alpha											
IG13	0.045%	0.106%	0.178%	0.101%	0.077%	0.090%	0.017%	0.044%	0.088%	-0.150%	0.194%
	0.46	1.36	2.72	1.60	1.22	1.45	0.26	0.59	1.08	-1.33	1.45
IG1	-0.043%	0.016%	0.148%	0.044%	0.166%	0.086%	0.004%	0.121%	-0.109%	-0.222%	0.179%
	-0.44	0.21	2.18	0.67	2.72	1.58	0.06	1.73	-1.35	-2.12	1.43
IG2	0.099%	-0.036%	0.113%	0.060%	0.057%	0.063%	0.054%	0.116%	-0.041%	-0.136%	0.234%
	1.09	-0.45	1.64	0.94	0.96	1.11	0.81	1.52	-0.44	-1.31	1.91
IG3	-0.075%	0.044%	0.096%	0.123%	0.108%	0.054%	0.049%	0.067%	0.051%	-0.123%	0.047%
	-0.84	0.60	1.42	2.07	1.75	0.98	0.76	0.82	0.61	-1.19	0.39
FFC alpha											
IG13	0.161%	0.170%	0.259%	0.164%	0.120%	0.121%	0.066%	0.124%	0.164%	0.107%	0.054%
	1.66	2.16	3.91	2.57	1.86	1.90	0.98	1.63	1.97	0.99	0.40
IG1	0.137%	0.087%	0.174%	0.146%	0.245%	0.105%	0.004%	0.222%	0.026%	-0.027%	0.165%
	1.43	1.08	2.50	2.22	3.97	1.89	0.06	3.17	0.32	-0.27	1.28
IG2	0.176%	0.054%	0.189%	0.145%	0.087%	0.109%	0.146%	0.168%	0.130%	0.092%	0.085%
	1.92	0.67	2.70	2.27	1.43	1.89	2.19	2.17	1.41	0.92	0.69
IG3	0.049%	0.141%	0.155%	0.171%	0.175%	0.088%	0.119%	0.189%	0.178%	0.055%	-0.006%
	0.54	1.89	2.26	2.82	2.79	1.56	1.80	2.33	2.16	0.54	-0.05

This table presents 5 categories of portfolio excess returns and abnormal returns (alphas). Panel A presents value-weighted and equally-weighted portfolio excess returns sorted by deciles of IG13, IG1, IG2, and IG3. All growth measures (IG) are the growth measures defined in Table 1. Panel B presents value-weighted portfolio abnormal returns (alphas) sorted by deciles of IG13, IG1, IG2, and IG3. Alphas are computed using the Capital Asset Pricing model (CAPM), Fama-French (1993) model (FF), and Fama-French-Carhart (1997) model (FFC). L-H refers to the hedge portfolio return of longing lowest and shorting highest deciles. t-statistics are reported below the parameter estimates.

TABLE 4
PERFORMANCE OF INVESTMENT GROWTH PORTFOLIOS UNDER DIFFERENT LIMIT-TO-ARBITRAGE CATEGORIES

Panel A:

	L	2	3	4	H	L-H	L	2	3	4	H	L-H
	Value Weighted: high IVOL						Equally Weighted: high IVOL					
IG1	1.011%	1.043%	0.689%	0.609%	0.376%	0.635%	1.302%	1.207%	1.107%	1.088%	0.819%	0.483%
	3.65	3.67	2.39	2.01	1.25	4.13	4.67	4.44	4.16	4.06	3.08	5.58
IG2	0.758%	0.805%	0.709%	0.738%	0.565%	0.194%	1.153%	1.129%	1.115%	1.131%	0.970%	0.183%
	2.62	2.72	2.42	2.46	1.96	1.32	4.20	4.17	4.14	4.20	3.62	2.05
IG3	0.748%	0.672%	0.748%	0.794%	0.624%	0.123%	1.133%	1.114%	1.097%	1.134%	1.024%	0.109%
	2.71	2.27	2.53	2.71	2.05	0.88	4.24	4.17	4.05	4.16	3.73	1.33
	Value Weighted: low IVOL						Equally Weighted: low IVOL					
IG1	0.626%	0.639%	0.631%	0.559%	0.474%	0.152%	0.904%	0.869%	0.789%	0.789%	0.714%	0.190%
	3.64	4.05	4.31	3.41	2.56	1.32	5.66	5.83	5.32	5.07	4.45	3.12
IG2	0.609%	0.566%	0.620%	0.628%	0.351%	0.258%	0.884%	0.828%	0.807%	0.809%	0.767%	0.118%
	3.52	3.61	4.18	3.87	1.82	1.90	5.62	5.52	5.39	5.22	4.83	2.04
IG3	0.611%	0.654%	0.565%	0.525%	0.566%	0.045%	0.791%	0.821%	0.828%	0.794%	0.878%	-0.088%
	3.71	4.31	3.76	3.09	3.01	0.39	5.16	5.54	5.51	5.04	5.38	-1.46

Panel B:

	L	2	3	4	H	L-H	L	2	3	4	H	L-H
	CAPM alpha under high IVOL						FF alpha under high IVOL					
IG1	0.171%	0.209%	-0.150%	-0.315%	-0.519%	0.691%	0.099%	0.207%	-0.047%	-0.281%	-0.424%	0.523%
	1.17	1.29	-0.90	-2.00	-3.13	4.47	0.86	1.48	-0.32	-1.96	-2.96	3.41
IG2	-0.108%	-0.057%	-0.155%	-0.137%	-0.318%	0.210%	-0.146%	0.012%	-0.141%	-0.081%	-0.257%	0.110%
	-0.69	-0.33	-0.94	-0.79	-2.17	1.42	-1.12	0.08	-0.97	-0.56	-1.98	0.75
IG3	-0.084%	-0.203%	-0.105%	-0.074%	-0.291%	0.207%	-0.135%	-0.151%	-0.031%	-0.025%	-0.240%	0.105%
	-0.57	-1.24	-0.60	-0.45	-1.77	1.48	-1.13	-0.99	-0.20	-0.18	-1.77	0.75
	CAPM alpha under low IVOL						FF alpha under low IVOL					
IG1	0.095%	0.128%	0.146%	0.024%	-0.105%	0.200%	-0.038%	0.090%	0.134%	0.046%	-0.084%	0.047%
	1.12	1.97	2.76	0.37	-1.19	1.73	-0.46	1.47	2.84	0.73	-0.95	0.41
IG2	0.078%	0.053%	0.130%	0.104%	-0.231%	0.309%	-0.008%	0.063%	0.109%	0.096%	-0.218%	0.210%
	0.89	0.86	2.38	1.52	-2.25	2.26	-0.09	1.07	2.26	1.49	-2.08	1.52
IG3	0.100%	0.158%	0.071%	-0.023%	-0.023%	0.123%	0.042%	0.130%	0.057%	0.013%	-0.016%	0.058%
	1.24	2.65	1.23	-0.32	-0.26	1.07	0.52	2.30	1.16	0.18	-0.18	0.50

Panel C:

	L	2	3	4	H	L-H
			FFC alpha under high IVOL			
IG1	0.221%	0.268%	0.023%	-0.049%	-0.114%	0.334%
	1.90	1.87	0.15	-0.34	-0.82	2.16
IG2	0.046%	0.051%	-0.012%	0.064%	0.030%	0.016%
	0.35	0.33	-0.08	0.44	0.24	0.10
IG3	0.080%	0.083%	0.041%	0.156%	-0.046%	0.126%
	0.68	0.54	0.26	1.10	-0.34	0.88
			FFC alpha under low IVOL			
IG1	-0.005%	0.165%	0.176%	0.069%	0.017%	-0.022%
	-0.06	2.68	3.67	1.06	0.19	-0.19
IG2	0.022%	0.154%	0.126%	0.162%	-0.088%	0.110%
	0.25	2.60	2.53	2.47	-0.83	0.78
IG3	0.088%	0.169%	0.090%	0.115%	0.063%	0.025%
	1.07	2.94	1.78	1.62	0.68	0.21

Panel D:

	H-L IVOL					
	CAPM		FF		FFC	
	L IG	H IG	L IG	H IG	L IG	H IG
IG1	0.076%	-0.415%	0.137%	-0.340%	0.226%	-0.131%
	0.44	-2.20	0.95	-2.08	1.54	-0.80
IG2	-0.186%	-0.087%	-0.138%	-0.039%	0.024%	0.118%
	-1.00	-0.50	-0.87	-0.24	0.15	0.73
IG3	-0.184%	-0.268%	-0.177%	-0.224%	-0.009%	-0.110%
	-1.09	-1.43	-1.23	-1.35	-0.06	-0.65

This table presents portfolio excess and abnormal (alpha) returns under high and low idiosyncratic volatility (IVOL) terciles. Panel A presents value-weighted and equally-weighted portfolio excess returns sorted by quintiles of IG1, IG2, and IG3. All growth measures (IG) are the investment growth measures defined in Table 1. Panels B and C present portfolio abnormal returns (alphas) sorted by quintiles of IG1, IG2, and IG3. Alphas are computed using the Capital Asset Pricing model (CAPM) and Fama-French (1993) model (FF) in Panel B, and Fama-French-Carhart (1997) model (FFC) in Panel C. L-H refers to the hedge portfolio return of longing lowest and shorting highest quintiles. Panel D presents portfolio abnormal return (alpha) difference by longing high and shorting low idiosyncratic volatility portfolio sorted by quintiles of IG1, IG2, and IG3. t-statistics are reported below the parameter estimates.