Effects of Growth Options on the Post-Earnings Announcement Drift

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This paper shows that growth options, measured by the market-asset to book-asset ratio (MABA), have significant effects on the post-earnings announcement drift. First, the abnormal returns during the post-earnings announcement period are significantly and negatively correlated to the growth options. This indicates that the traditional benchmark of abnormal returns might not have been able to capture the real underlying risks. Further, the negative relation between growth options and the drift is especially significant for firms with positive earnings surprises. Collectively, our findings suggest that there are asymmetry effects of growth options on the post-earnings announcement drift.

INTRODUCTION

Ball and Brown (1968) observe that following a positive (negative) earnings surprise a firm encounters an upward (downward) abnormal return, which they define as post-earnings announcement drift (*PEAD*). Shivakumar (2007) calls the phenomena "the longest standing anomaly in the finance and accounting literature," and Kothari (2001) concludes that ''the *PEAD* anomaly poses a serious challenge to the efficient markets hypothesis". Konchitchki et al. (2013) point out that the continued existence of the *PEAD* remains the center of interest for many researchers.

Researchers have provided several, sometimes contrasting hypotheses for the *PEAD*. Particularly, Bernard and Thomas (1989) suggest two main explanations: the first is information delay, which comes either from the failure of the market to integrate available information or from market friction where costs exceed benefits for traders to profit by exploiting the information.

For examples on the market's failure to integrate information, Mendenhall (1991), Abarbanell and Bernard (1992), Bartov (1992), Ball and Bartov (1996) argue that investors under-react to earnings surprises and fail to understand the implication of current earnings for future earnings correctly. Therefore, *PEAD* is probably a further adjustment of price to reflect the under-reaction of market participants at the beginning of the earnings announcement. Alternatively, Daniel et al. (1998) and Fischer (2001) demonstrate that the under-reaction is due to investors' overconfidence regarding their private and heterogeneous information, and this overconfidence in having private information (as opposed to the information embedded in the public earnings announcements) results in the drift by overweighting the heterogeneous private information and underweighting the public information. Simarly, Zhang (2006), Francis et al. (2007), Anderson, Harris, and So (2007), as well as Angelini and Guazzarotti (2010) demonstrate that the uncertainty of the quality of information signal may have caused investor's under-reaction to the earnings announcement. As an example of market friction, Bhushan (1994) points out that transaction cost can play a role in preventing market participants from profiting on the *PEAD*. Mendenhall (2004) also shows that arbitrage risk affects the *PEAD*.

The alternative explanation is *CAPM*'s failure to capture the real risks used in calculating subsequent cumulative abnormal returns. To provide a few examples, Foster, Olsen, and Shevlin (1984), Ball, Kothari and Watts (1993), and Bernard and Seyhun (1997) imply that companies with "good" news are inherently riskier compared with those with "bad" news. Alternatively, Sadka (2006) indicates that the *PEAD* can be partially attributed to the illiquidity of the particular stocks. Furthermore, Bird, Choi, and Yeung (2014) demonstrate that *PEAD* is also related to investor's sentiment during the post-earnings announcement period.

Myers (1977) considers a firm as a portfolio of assets already in place and future growth options. Relatedly, Berk, Green, and Naik (1999) suggest that the firm's expected returns depend on the average systematic risk of assets-in-place, the number and value of growth options, and interest rate. Accordingly, the risk exposure of a firm's equity depends on the weight of assets in place and growth options, which dynamically adjust to optimal investment decisions over time. Since growth options are unobservable, the best way to capture them is to use proxies. Adam and Goyal (2008) show that the market-to-book assets (*MABA*) ratio is one of the best proxies for investment opportunities and it is relatively independent of other factors. Here, book value of assets captures assets-in-place, and market value of assets captures total assets including assets-in-place and growth options. Therefore, a low *MABA* ratio implies that there are relatively fewer investment opportunities for a firm compared with its assets-in-place. The *MABA* ratio integrates both the current market value and market's anticipated growth opportunities in the foreseeable future. Specifically, the *MABA* ratio integrates information about a firm's risk relative to the scale of total assets.

Furthermore, a firm's market value is contingent on the firm's asset portfolio along with its investment cycle. The market value of a firm increases when the firm invests in projects with low systematic risk. Additionally, when the firm invests in these opportunities, its cash flow decreases in the subsequent time horizon, which on average leads to low realized returns. For example, Carlson, Fisher, and Giammarino (2004) demonstrate that a firm's systematic risks vary with the exercise of growth options. Anderson and Garcia-Feijóo (2006) show that portfolios based on investment-growth rates have higher subsequently monthly returns, especially when firms accelerate investment spending. Relatedly, Da, Guo, and Jagannathan (2012) show that adjustment of options can eliminate several anomalies, indicating the existence of other risks that current asset pricing models may have failed to capture.

In this paper, we examine the impact of growth options on the *PEAD*. We ask two research questions. 1) Is there a negative relationship between the market-to-book asset (*MABA*) ratios and abnormal returns during the post-earnings announcement drift? 2) Is there an interaction effect between the *PEAD* and *MABA* ratio? To answer these questions, we provide empirical evidence that during the post-earnings announcement periods firms with lower growth options tend to have lower returns. Also, while the firms with low growth options tend to have stronger *PEAD*, the interaction effect mainly comes from firms with positive earnings surprises.

The remainder of the paper is structured as follows: Section 2 illuminates the data and methodology used in the study. Section 3 reports and discusses the empirical results, including robustness check. Section 4 summarizes the findings and provides directions for future research.

METHODOLOGY AND DATA

Carhart-4-Factor Model and Abnormal Returns

Carhart (1997) developed the Carhart-4-factor model to measure abnormal returns. The Carhart-4-factor model covers both the Fama-French 3-factor model (1992, 1993) and momentum factor (Jegadeesh & Titman (1993), with the equation as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{1,t}\left(R_{m,t} - R_{f,t}\right) + \beta_{2,i}SMB_i + \beta_{3,i}HML_i + \beta_{4,i}UMD_i + \varepsilon_{i,t} \quad (1)$$

In the equation, $R_{i,t}$ is the return for common stock of firm j on day t. $R_{f,t}$ is the three-month T-bill interest rate, a proxy for the risk-free rate of return on day t. $R_{m,t}$ is the return on day t for the market proxy of the S&P 500. SMB_t is the average return on small market-capitalization portfolios minus the average return on large market-capitalization portfolios. HML_t is the average return on high book-to-market equity portfolios minus the average return on low book-to-market equity portfolios. UMD_t is equal to the average return on high prior 12-month return portfolios minus the average return on low prior 12-month return portfolios (except for month t-1). The α_i is the abnormal model from the pricing model. $\beta_{1,i}$, $\beta_{2,i}$, $\beta_{3,i}$, and $\beta_{4,i}$ measure the sensitivity of $R_{i,t}$ to different corresponding factors, respectively. The $\varepsilon_{i,t}$ is the error term with an expected value of zero. The data source for the Carhart-4-factor model and $R_{i,t}$ is the Center for Research on Security Prices (CRSP) at the University of Chicago and WRDS.

Abnormal returns ($AR_{i,t}$) are computed as the difference between actual returns and expected returns using the above Carhart-4-factor model:

$$AR_{i,t} = R_{i,t} - R_{f,t} - [\hat{\beta}_{1,t}\left(R_{m,t} - R_{f,t}\right) + \hat{\beta}_{2,i}SMB_i + \hat{\beta}_{3,i}HML_i + \hat{\beta}_{4,i}UMD_i \quad (2)$$

where $AR_{i,t}$ and $R_{i,t}$ are the abnormal and real returns, respectively, for announcement i in event window t. In this paper, we use buy-and-hold abnormal returns ($BHAR$) to measure abnormal returns during the post-earnings announcement periods, where $BHAR$ is the difference between the actual compound return during the period of (t_1, t_2) and its corresponding expected return without the earnings announcement:

$$BHAR_i = \prod_{t=t1}^{t2}(1 + R_{i,t}) - \mathrm{E}(\prod_{t=t1}^{t2}(1 + R_{i,t}) \quad (3)$$

where t_1 and t_2 are, respectively, the first and the last trading day of the target window over which daily return, or $R_{i,t}$, is compounded.

Estimation of Earnings Surprise and Sales Surprise

We follow the analysts' forecasts model developed by Livnat and Mendenhall (2006), which define the standardized unexpected earnings (SUE) as follows:

$$SUE_{i,t} = \frac{E_{i,t}^{IBES} - E_{i,t}^{AF}}{P_{i,t}} \quad (4)$$

In the equation, $E_{i,t}^{IBES}$ is the actual EPS reported in I/B/E/S, and $E_{i,t}^{AF}$ is the mean of the analysts' quarterly forecasts of EPS during the 90-day period prior to the disclosure of the actual earnings for firm i. $P_{i,t}$ is the price per share for firm i at the end of quarter t as obtained from Compustat.

Standardized unexpected sales (SUS) are then calculated as:

$$SUS_{i,t} = \frac{S_{i,t}^{IBES} - S_{i,t}^{AF}}{P_{i,t}} \quad (5)$$

where $S_{i,t}^{IBES}$ is the actual sales reported in I/B/E/S and $S_{i,t}^{AF}$ is the mean of the analysts' quarterly forecasts of sales during the 90-day period prior to the disclosure of the actual earnings for firm i.

Proxies of Growth Options

Following Cao, Simin and Zhao (2006), we use the *MABA* ratio to capture growth options. The *MABA* ratio integrates the market value and the market's anticipated growth opportunities in the future for the firm. Another popular proxy for growth options is Tobin's Q. These two proxies are widely used as growth options in such papers as Collins and Kothari (1989), Chung and Charoenwong (1991), Smith and Watts (1992), Berk, Green, and Naik (1999), Goyal, Lehn and Racic (2002), Carlson, Fisher, and Giammarino (2004), and Anderson and Garcia-Feijóo (2006). For brevity, this paper only demonstrates results from *MABA*, as our tests (untabulated) show that results for Tobin's Q are quite similar.

Data

We gather information on quarterly earnings per share (*EPS*), quarterly sales per share (*SPS*), announcement dates, and the mean analyst forecasts from the Institutional-Brokers-Estimate-System summary statistics files (I/B/E/S). We obtain data on stock returns from the Center for Research on Security Prices (CRSP) at the University of Chicago. We also adjust for stock splits and stock dividends so that all returns and earnings are aligned on a comparable basis.

The sample period is between June 1998 and December 2011. To calculate the earnings surprise measured by analysts' forecasts, the company should at least have one analyst forecast from the I/B/E/S database. Moreover, the company's shares should be traded on the New York Stock Exchange, American Stock Exchange, or NASDAQ. The sample excludes companies with market value of equity less than $5 million at the end of quarter t-1 and also excludes companies with a price less than $1 in Compustat.

EMPIRICAL RESULTS

Descriptive Statistics

Descriptive statistics are summarized in Table 1, which includes the *MABA* ratio, earnings surprise (*SUE*), sales surprise (*SUS*), abnormal returns in earnings announcement period (-1, +1) (*EAAR*), abnormal returns in post-earnings announcement periods (+2, +60) (*PEAAR*), and the firm's characteristics such as idiosyncratic volatility (*ARB*), illiquidity (*ILLIQ*), price (*PRC*), trading volume (*VOL*) and market value (*MV*). More information about the definition and calculation of the variables are provided in the Appendix. Overall, the sample consists of 60,518 firm-quarter observations between 1998 and 2011.

Table 1 shows that average earnings surprise is close to zero and that the mean is equal to the median (50^{th} pctl). In contrast, sales surprise is skewed to the left since its mean is negative (-0.0380) compared with its median. As for the *MABA* ratio, the mean is 2.1619 compared with the median of 1.6097, indicative of positive skewness of the distribution.

TABLE 1
DESCRIPTIVE STATISTICS

Variable	Mean	Std Dev	10th Pctl	25th Pctl	50th Pctl	75th Pctl	90th Pctl
SUE	0.0005	0.0115	-0.0033	-0.0002	0.0005	0.0021	0.0056
SUS	-0.0380	5.5943	-0.0808	-0.0210	0.0085	0.0411	0.0911
MABA	2.1619	1.7696	1.0063	1.1723	1.6097	2.4713	3.8903
EAAR	0.0038	0.0883	-0.0914	-0.0387	0.0024	0.0467	0.1019
PEAAR	-0.0050	0.2017	-0.2178	-0.1005	-0.0039	0.0915	0.2065
ARB	0.1286	0.0756	0.0566	0.0785	0.1118	0.1599	0.2177
ILLIQ	0.7591	6.8051	0.0014	0.0061	0.0332	0.1869	0.9225
PRC	33.77	19.29	5.42	11.39	22.31	36.91	54.25
VOL	344084	1250646	9085	27755	82660	249832	720271
MV(Mil)	5991	21381	128	313	932	3187	11690

The sample consists of 60,518 quarterly firm earnings announcement observations during 1998-2011. *SUE* is the standardized unexpected earnings measured by analysts' forecasts. *SUS* is the standardized unexpected sales surprises. *EAAR* is the buy-and-hold abnormal returns during the earning announcement window of (-1, +1). *PEAAR* is buy-and-hold abnormal returns during the post-earnings announcement period of (+2, +60). *ARB* is the arbitrage risk. *ILLIQ* is the illiquidity. *PRC* is the price and *VOL* is the trading volume. More information about definition and calculation of variables can be found in the Appendix.

The average *EAAR* is 0.0038 while the average *PEAAR* is -0.0050. The distributions of price and market value are quite similar to those reported in Truong, Shane, and Zhao (2016). The mean of the arbitrage risk (*ARB*) is 0.1286, larger than that reported by Yan and Zhao (2011) with a sample between 1984 and 2008. This can be due to the increase of idiosyncratic volatility documented by Fink, Fink, Grullon & Weston (2010). The mean of illiquidity is 0.7591, which is a little lower than the mean of 0.830 as reported in Chordia, Goyal, Sadka, Sadka, and Shivakumar (2009) with the sample period of 1972-2005, indicative of improved market liquidity.

Regression Results

Table 2 provides Fama-MacBeth cross-sectional regressions (1973) of buy-and-hold abnormal returns (dependent variable) on variables including the *MABA* ratio and earnings/sales surprises that might have driven the abnormal returns during earnings announcement. The coefficients in Table 2 are the average of *N* monthly coefficients, and T-statistics in parenthesis are based on the standard deviations of these coefficients.

TABLE 2
REGRESSIONS OF *EAAR* ON *SUE*, *SUS*, *MABA* AND THEIR INTERACTIONS

VARIABLE	MODEL1	MODEL2	MODEL3	MODEL4	MODEL5	MODEL6
INTERCEPT	0.003***	0.004***	0.006***	0.007***	0.003***	0.003***
	(4.12)	(4.35)	(3.40)	(3.63)	(3.33)	(4.30)
SUE	0.042***			0.036***	0.038***	
	(18.44)			(15.62)	(13.32)	
SUS		0.026***		0.016***		0.021***
		(13.84)		(10.63)		(7.28)
MABA			-0.001**	-0.001**		
			(-2.03)	(-2.13)		
MABA_SUE					0.001**	
					(2.48)	
MABA_SUS						0.001**
						(2.53)
ADJRSQ	0.109***	0.045***	0.005**	0.132***	0.116***	0.054***
N	60518	60518	60518	60518	60518	60518

Coefficients of the regressions are averaged monthly across the sample period from Oct. 1998 to Dec. 2011. T-statistics in parentheses are calculated by using the Fama-MacBeth (1973) method, and the parameter of lag in the Newey and West (1987) formula is equal to 3. More information about the definition of variables is provided in Appendix A. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 2 shows that there is a positive relationship between the earnings announcement abnormal returns and the earnings surprises. The coefficient is equal to 0.042, which is larger than 0.030 reported by Truong, Shane, and Zhao (2016). On the other hand, earnings announcement abnormal returns increase with the increase of sales surprises, with a coefficient of 0.026. The coefficients on earnings surprises and sales surprises are both highly significant, consistent with that reported by Jegadeesh and Livnat (2006).

Although the magnitudes of coefficients are low, there is a negative relationship between *EAAR* and *MABA*. The coefficient of interaction between *MABA* and *SUE* is positive, suggesting that market reaction to the earnings surprise increases for firms with higher *MABA* ratios. The results in Model 6 (Table 2) indicate that market reaction to sales surprise also increases for firms with higher *MABA* ratios.

Model 7 in Table 3 shows that the *PEAAR* is not significantly correlated with the earnings surprise, while Model 8 shows that there is a statistically significant negative relationship between the *PEAD* and sales surprises. Model 9 also indicates that there is a statistically significant positive relationship between *PEAAR* and *EAAR*. Model 10 in Table 3 shows that there is a statistically significant negative relationship between the *MABA* ratio and the *PEAAR*. The sign of the coefficient is negative during the post-earnings announcement period, which is opposite to that during the earnings announcement period. This is consistent with what has been found by Yan and Zhao (2011); they show that value firms, i.e., firms with low market-to-book equity ratio (*MEBE*), have muted initial reaction during the announcement window compared with the glamour firms. Noticeably, Yan and Zhao (2011) use the book-to-market equity ratio (*MEBE*) to distinguish glamour stocks from value stocks. Here, we use the *MABA* ratio, a proxy for growth options. Penman, Richardson, and Tuna (2007) indicate that there is a one-on-one link between book-to-market assets (*BA/MA*) and book-to-market equity (*BE/ME*) and that high-value premium (high *BE/ME*) can come from high operating leverage (low growth options), high financial leverage, or both.

TABLE 3
REGRESSIONS OF *PEAAR* ON *SUE*, *SUS*, *EAAR*, AND *MABA*

VARIABLE	MODEL7	MODEL8	MODEL9	MODEL10	MODEL11
INTERCEPT	-0.039***	-0.039***	-0.039***	0.022**	0.021*
	(-3.69)	(-3.70)	(-3.71)	(2.00)	(1.89)
SUE	-0.003				-0.005
	(-0.63)				(-0.91)
SUS		-0.022***			-0.015***
		(-3.87)			(-3.03)
EAAR			0.012**		0.013**
			(2.42)		(2.51)
MABA				-0.013***	-0.013***
				(-8.41)	(-8.55)
ADJRSQ	0.003	0.009***	0.005***	0.028***	0.048***
N	60518	60518	60518	60518	60518

Coefficients of the regressions are averaged monthly across the sample period from Oct. 1998 to Dec. 2011. T-statistics in parentheses are calculated by using the Fama-MacBeth (1973) method, and the parameter of lag in the Newey and West (1987) formula is equal to 3. More information about the definition of variables is provided in Appendix A. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Model 10 in Table 3 also shows that the *MABA* ratio has more power (R_2=0.028) in explaining the abnormal returns compared with a factor of sales surprise (R_2=0.009) and *EAAR* (R_2=0.005). R_2 increases to 0.048 when integrating all different independent variables together in Model 11. This implies that the *MABA* does not subsume other independent variables and that the *MABA* ratio has the incremental ability in explaining the post-earnings announcement drifts. Furthermore, the magnitude of the coefficient for *MABA* in the post-announcement window increases by thirteen times compared with that in the announcement window.

When the interaction term of *SUE* and *MABA* is integrated, the positive relationship between *SUE* and *PEAD* is recovered, as shown in Model 12 (Table 4), with a coefficient of 0.016 and t-statistics of 2.04. The magnitude of the coefficient for *SUS* decreases from 0.22 in Model 8 (Table 3) to 0.11 in Model 13 (Table 4) after adding interaction term of *MABA* and *SUS*. Model 14 (Table 4) indicates that the interaction between MABA and EAAR is not significant. In Model 15 (Table 4), the negative relationship between *MABA* and the drift (via the interaction between *MABA* and *SUE*) holds when integrating all different independent variables, including *SUE*, *SUS*, *EAAR*, and their corresponding interaction terms with the *MABA* ratio. Also, Model 15 shows there is a negative relationship between the *MABA* ratio and *PEAAR*. Model 16 (Table 4) indicates that both negative relationships hold and they are not sensitive to other control variables such as arbitrage risk, liquidity risk (via illiquidity and volume), and price.

TABLE 4
FAMA-MACBETH REGRESSIONS OF *PEAAR* ON *SUE*, *SUS*, *EAAR*, *MABA* AND THEIR RELATED INTERACTION TERMS, WITH OTHER CONTROL VARIABLES INCLUDING *ARB*, *PRC*, *ILLIQ*, *VOL*

VARIABLE	MODEL12	MODEL13	MODEL14	MODEL15	MODEL16
INTERCEPT	-0.040***	-0.038***	-0.038***	0.020*	0.021*
	(-3.76)	(-3.64)	(-3.62)	(1.74)	(1.78)
SUE	0.016**			0.023**	0.036
	(2.04)			(2.11)	(1.31)
SUS		-0.011*		-0.011	-0.011
		(-1.68)		(-1.42)	(-1.36)
EAAR			0.011*	0.007	0.020
			(1.76)	(0.98)	(1.24)
MABA				-0.013***	-0.014***
				(-8.69)	(-8.41)
MABA_SUE	-0.005***			-0.007***	-0.009***
	(-2.69)			(-2.66)	(-2.62)
MABA_SUS		-0.003*		-0.001	-0.000
		(-1.87)		(-0.46)	(-0.11)
MABA_EAAR			-0.001	0.001	-0.002
			(-0.37)	(0.61)	(-0.41)
ARB_SUE					-0.002
					(-0.65)
PRC_SUE					0.001
					(0.43)
ILLIQ_SUE					0.001
					(0.24)
VOL_SUE					-0.002
					(-1.01)
ADJRSQ	0.011***	0.008**	0.015***	0.051***	0.064***
N	60518	60518	60518	60518	60518

Coefficients of the regressions are averaged monthly across the sample period from Oct. 1998 to Dec. 2011. T-statistics in parentheses are calculated by using the Fama-MacBeth (1973) method, and the parameter of lag in the Newey and West (1987) formula is equal to 3. More information about the definition of variables is provided in Appendix A. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Robustness Check

To investigate the sensitivity of our results to different sub-samples, we first break the sample into two groups based on the nature of the earnings surprises: one with negative earnings surprise and the other one with a positive earnings surprise. As presented in Table 5, the coefficients of *MABA* during the *PEAD* are the same, -0.011, for two different sub-samples but the magnitude of the t-statistics is larger for the group with positive *SUE*. For the sub-sample with positive *SUE*, the coefficient of the *MABA_SUE* on *PEAAR* is 0.016, which is larger than that of 0.007 for the whole sample in Model 15 (Table 4). The magnitude of t-statistics is equal to 3.10, which is also larger than that of 2.66 for the whole sample. These results indicate that the negative relationship between *MABA* and *PEAAR* mainly comes from firms with positive *SUE*.

TABLE 5
FAMA-MACBETH REGRESSIONS OF *PEAAR* ON *SUE*, *SUS*, *EAAR*, *MABA* AND THEIR RELATED INTERACTION TERMS FOR DIFFERENT SUB-SAMPLES

VARIABLE	SUE>0	SUE<0	1998--2004	2005--2011
INTERCEPT	0.001	-0.026	0.025	0.019*
	(0.05)	(-0.89)	(1.23)	(1.78)
SUE	0.071***	-0.041	0.034*	0.016*
	(4.35)	(-1.00)	(1.70)	(1.71)
SUS	0.022	-0.021	-0.019	-0.003
	(1.23)	(-1.54)	(-1.51)	(-0.39)
EAAR	0.011	-0.015	0.014	-0.005
	(0.97)	(-0.85)	(1.62)	(-0.48)
MABA	-0.011***	-0.011*	-0.017***	-0.010***
	(-5.51)	(-1.73)	(-7.03)	(-7.06)
MABA_SUE	-0.016***	-0.002	-0.012**	-0.003*
	(-3.10)	(-0.15)	(-2.32)	(-1.89)
MABA_SUS	-0.004	-0.002	-0.002	0.000
	(-1.58)	(-0.56)	(-0.54)	(0.09)
MABA_EAAR	0.004	0.015	0.004	0.000
	(1.23)	(1.30)	(1.53)	(0.03)
ADJRSQ	0.067***	0.089***	0.066***	0.039***
N	37644	22874	21084	39434

The different sub-samples include: 1) those with positive earnings surprise; 2) those with negative earnings surprises; 3) those during 1998-2004; 4) those during 2005-2011. Coefficients of the regressions are averaged monthly. T-statistics in parentheses are calculated by using the Fama-MacBeth (1973) method, and the parameter of lag in the Newey and West (1987) formula is equal to 3. More information about the definition of variables is provided in Appendix A. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

The sample is also divided into two groups with different sub-periods. Table 5 shows that there is a negative relationship between *MABA* and *PEAAR* during sub-periods of 1984-2004 and 2005-2011. The negative relationship between *MABA* and *PEAAR* also holds for these two sub-periods. Both negative relationships are stronger during 1998-2004, with a coefficient of -0.017 for *MABA* (t=-7.03) and -0.012 for the interaction term of *MABA* and *SUE* (t=-2.32), compared with those during 2005-2011, with a coefficient of -0.010 for MABA (t=-7.06) and -0.003 for its interaction term (t=-1.89). Table 6 provides similar results and demonstrates that the *MABA* ratio has significant effects on the post-earnings announcement abnormal returns after adding other control variables. These results also indicate that there is a negative relationship between the *MABA* ratio and the *PEAAR*, and that the drifts are more likely to survive for firms with low *MABA* ratios.

TABLE 6
REGRESSIONS OF *PEAAR* ON *SUE*, *SUS*, *EAAR*, *MABA* AND THEIR RELATED INTERACTION TERMS FOR DIFFERENT SUB-SAMPLES

VARIABLE	SUE>0	SUE<0	1998--2004	2005--2011
INTERCEPT	-0.018	-0.067	0.023	0.024*
	(-0.86)	(-1.48)	(1.14)	(1.86)
SUE	0.205***	-0.188***	0.002	0.074***
	(3.67)	(-2.83)	(0.05)	(2.81)
SUS	0.026	-0.013	-0.022*	-0.001
	(1.00)	(-0.98)	(-1.79)	(-0.10)
EAAR	0.027	-0.004	0.010	0.024
	(1.25)	(-0.17)	(1.30)	(0.78)
MABA	-0.008***	-0.007	-0.018***	-0.010***
	(-3.73)	(-0.90)	(-6.95)	(-6.17)
MABA_SUE	-0.019**	-0.002	-0.015**	-0.004
	(-2.18)	(-0.12)	(-2.36)	(-1.64)
MABA_SUS	-0.005	-0.004	-0.001	0.000
	(-1.02)	(-1.16)	(-0.27)	(0.31)
MABA_EAAR	-0.002	0.008	0.005*	-0.006
	(-0.36)	(0.73)	(1.68)	(-0.82)
ARB_SUE	-0.009*	0.013***	0.003	-0.007
	(-1.91)	(3.51)	(1.13)	(-1.58)
PRC_SUE	-0.011***	0.019***	0.006	-0.003
	(-2.81)	(2.80)	(1.15)	(-1.40)
ILLIQ_SUE	-0.002	0.003	0.002	-0.002
	(-0.55)	(0.50)	(0.67)	(-0.62)
VOL_SUE	-0.002	-0.006	0.000	-0.004*
	(-0.47)	(-1.30)	(0.05)	(-1.67)
ADJRSQ	0.098***	0.122***	0.074***	0.054***
N	37644	22874	21084	39434

The different sub-samples include: 1) those with positive earnings surprise; 2) those with negative earnings surprises; 3) those during 1998-2004; 4) those during 2005-2011, with other control variables of *ARB*, *PRC*, *ILLIQ,* and *VOL*. Coefficients of the regressions are averaged monthly. T-statistics in parentheses are calculated by using the Fama-MacBeth (1973) method, and the parameter of lag in the Newey and West (1987) formula is equal to 3. More information about the definition of variables is provided in Appendix A. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

CONCLUSION AND FUTURE RESEARCH

This paper presents evidence that growth options, which are represented by the market-to-book asset ratio, have asymmetry effects on the post-earnings announcement drift. First, there is a negative relationship between growth options and post-earnings-announcement abnormal returns. This indicates that the benchmark traditionally used in calculating abnormal returns during the post-earnings announcement drift periods might not be accurate. On the other hand, the findings show that growth options also have negative effects on the drift, which suggests that firms with high growth options are less likely to drift. The negative effects mainly come from firms with positive earnings surprises. Further research on what are the roles of operating leverage and financial leverage on the post-earnings-announcement abnormal returns will be helpful for investors to understand the effects of growth options on the drift better.

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APPENDIX

DEFINITION OF VARIABLES

A. Proxies of growth options

1. *MABA* = log{[Total Assets - Total Common Equity + Price × Common Shares Outstanding] / Total Assets}

B. Proxies of surprises

2. *SUE*: Standardized unexpected earnings using analysts' forecasts. It is calculated as the actual earnings minus the mean analyst forecast from I/B/E/S during the 90-day period before the disclosure of financial statements, scaled by the price at the last quarter.
3. *SUS*: Standardized unexpected sales. It is calculated as the actual sales minus the mean of analyst forecast sales from I/B/E/S during the 90-day period before the disclosure of financial statements, scaled by the price at the last quarter.

C. Buy-and-hold abnormal returns

4. *EAAR*: Buy-and-hold abnormal returns in window (-1, +1), based on the Carhart-4-factor model.
5. *PEAAR*: Buy and hold abnormal return in window (+2, +60), based on the Carhart-4-factor model.

D. Control variables

6. *ARB*: Arbitrage risk. It is calculated as the residual variance from the market model regression estimated over the previous thirty-six months before the earnings announcement.
7. *ILLIQ*: Amihud (2002) illiquidity, calculated based on the ratio of absolute return to dollar volume in the last three months.
8. *PRC*: Closing stock price at the end of month prior to the earnings announcement.
9. *VOL*: Average daily trading volume over the previous three months.