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Sensitivity to investor sentiment and stock performance of open market share repurchases

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ABSTRACT

This paper finds that stocks of repurchasers with high sensitivity to investor sentiment are more likely to be mispriced. Thus, such repurchases are followed by superior post-buyback stock performance. This abnormal return associated with sensitivity to sentiment cannot be explained by other undervaluation factors: book-to-market or prior return effects. My results are robust with factor model analysis and controls for contamination effects. I conclude that this sentiment-driven undervaluation may result from the difficulty to value and/or limits to arbitrage rather than investor overreaction.

1. Introduction

Both practitioners and academics suggest that the undervaluation hypothesis is the one of the most important reasons for firms to buy back shares (Brav et al., 2005; Vermaelen, 1981). What types of repurchase firms are more likely to be undervalued? Ikenberry et al. (1995) and Chan et al. (2004) suggest that value firms, whose book-to-market ratios are high, are prone to be undervalued. Barth and Kasznik (1999) and Liang (2012) argue that the undervalued repurchase firms tend to be the firms with higher intangible assets because these firms are more likely to exhibit severe information asymmetry and to be mispriced. Peyer and Vermaelen (2009) propose that investors overreact to bad news, resulting in undervaluation of repurchase firms.[1]

The undervaluation prior to repurchasing shares is also called mispricing (Chan et al., 2004; Ikenberry et al., 1995, 2000). Behavioral finance studies suggest that the mispricing of stock arises from the sentiment of irrational investors.[2] This literature, in general, finds that for potential undervalued (overvalued) stocks, investors tend to undervalue (overvalue) the expected cash flows more when a firm has higher exposure to investor sentiment. Accordingly, the future return of a firm that is sensitive to sentiment would be higher (lower) than the return of a sentiment irrelevant firm. Baker and Wurgler (2006) argue that securities with a high sensitivity to sentiment tend to be highly subjectively valued and/or are very difficult to arbitrage. They thus find that these securities may be mispriced more often. Following this concept, I suggest that sensitivity of investor sentiment may affect the degree of mispricing of stocks prior to repurchases.

Repurchase firms that are more sensitive to the sentiment index are more likely to be mispriced. Studies suggest that repurchase firms experience poor past stock performance (e.g., Barth and Kasznik, 1999; Chan et al., 2004; Ikenberry et al., 1995), implying that the mispricing of repurchase firms is driven by undervaluation rather than overvaluation. To convey the information of undervaluation, firms have an incentive to make repurchase announcements and/or buyback their shares outstanding as a good self-investment signal. In addition, repurchase papers usually show significantly positive long-run post-buyback abnormal return to support the existence of undervaluation prior to repurchase. Accordingly, repurchasers with high sensitivity to sentiment are prone to be more undervalued than repurchasers with low sensitivity to sentiment. When those repurchase firms are undervalued more, their post-buyback stock performance should be higher.

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[1] Most recent papers, which are cited in this article, also explain the long-run outperformance of repurchase firms by the undervaluation story.

[2] Related studies include De Long et al. (1990), Shleifer and Vishny (1997), Neal and Wheatley (1998), Brown and Cliff (2005), Baker and Wurgler (2006, 2007), Kumar and Lee (2006), Lemmon and Portniaguina (2006), Stambaugh et al. (2012) and Mian and Sankaraguruswamy (2012).

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Therefore, I propose that when a firm with higher sensitivity to sentiment buys back shares, its stock will be undervalued more prior to repurchase and its abnormal return will be higher after the repurchase.

To examine this sentiment-driven mispricing effect, I use the investor sentiment index constructed by Baker and Wurgler (2006) and applied in a number of papers (Chung et al., 2012; Mian and Sankaraguruswamy, 2012; Stambaugh et al., 2012; Yu and Yuan, 2011). Baker and Wurgler's investor sentiment index represents investor views of the prospects of stocks. Thus, the sentiment index is a time-series variable. Researchers argue that the impact of sentiment on the stock valuation varies across stocks (Baker and Wurgler, 2006; Lemmon and Portniaguina, 2006).[3] Accordingly, I follow Baker and Wurgler (2006) by using the sensitivity to sentiment, which is the regression coefficient of the stock return against the sentiment index, as the key determinant in representing the cross-sectional mispricing effects.

I collect 6448 U.S. open market repurchase announcements from 1990 to 2010 and examine the relation between the sensitivity to sentiment and post-buyback stock return. First, I find that repurchase firms with higher sensitivity to sentiment have a lower percentage of shares held by institutional investors. Since the literature suggests that individual investors are speculative (Barber et al., 2009; Odean, 1999), lower levels of holding by institutional investors (i.e., more holding by individual investors) implies more individual speculative trading, leading to a higher sensitivity to sentiment. I next gauge the average buy-and-hold abnormal return (BHAR) of the share repurchases. Repurchase firms with the highest sensitivity to sentiment earn an average BHAR of 5.05% per year. By contrast, the average BHAR is not statistically significant (with a value of 0.95% per year) for repurchase firms with the lowest sensitivity to sentiment. It appears that repurchases outperform only when these stocks are highly sensitive to the sentiment index.

My sentiment-driven undervaluation story still holds after controlling for book-to-market (B/M) ratio and prior abnormal return. As mentioned above, B/M ratio and prior abnormal return are two proxy variables for capturing repurchase mispricing in the repurchase literature. Accordingly, I examine whether the sensitivity to sentiment predicts post-buyback period return only when the B/M ratio is high or the prior return is low. Repurchase firms with the highest sensitivity to sentiment earn the largest abnormal return in both the high and low B/M subgroups. Similarly, abnormal returns of repurchase firms with highest sensitivity to sentiment are largest in both the high and low prior return subsamples. I obtain similar results in the BHAR regression analysis. Therefore, the sensitivity to sentiment does not appear to be driven by B/M or prior return effect.

Undervaluation is inherently related to the information asymmetry. For the undervaluation hypothesis, researchers suggest that the stock return associated with repurchase announcements is higher for firms with low analyst coverage (Babenko et al., 2012; Chan et al., 2013). Based on regression analysis, the post-buyback BHAR is higher when analyst coverage is lower, especially for firms with high sensitivity to sentiment, suggesting that undervaluation is more pronounced with greater information asymmetry. When considering the self-selection effect, the results of the Heckman two-stage regression are consistent with my main findings.

Moreover, I gauge the abnormal return by using the Carhart (1997) four-factor model, which is identified as a robust approach for testing the efficient market hypothesis (Fama, 1998; Lyon et al., 1999; Mitchell and Stafford, 2000). The average monthly abnormal returns range from 0.29% to 0.38% for repurchase firms with the highest sensitivity to sentiment. By contrast, the abnormal returns are not significant for repurchase firms with the lowest sensitivity to sentiment. Thus, the results of the Carhart (1997) four-factor model are consistent with those of the BHAR findings mentioned above. Most interestingly, I finally add the sentiment index to the Carhart (1997) four-factor model and estimate post-buyback period abnormal returns. I find that the abnormal returns of the full repurchase sample and subsample are not statistically significant. The magnitude of the abnormal returns is largely about half or less than the abnormal returns estimated from the conventional Carhart (1997) four-factor model. Therefore, the outperformance of share repurchases can be at least partially explained by sentiment-driven mispricing.

Finally, I construct a few possible alternative explanations for the findings of this paper and test them. First, many other events could affect stock valuation in the two-year period for which I calculate the long run abnormal return. I address this potential contamination effect by removing repurchase cases that announce dividend initiations, dividend omissions, initial public offerings (IPOs), mergers and acquisitions, seasoned equity offerings (SEOs), and abnormal capital expenditures during the two year period after the repurchase date. The post-buyback BHAR remains higher for repurchases with high sensitivity to sentiment than repurchases with low sensitivity to sentiment. In addition, in order to increase credibility of my argument, I measure the sensitivity to sentiment by some other factor models. The results from robust checks are still consistent with my argument. Furthermore, I examine whether the post-buyback abnormal return results from the prior or post investor overreaction. After controlling for the prior abnormal return, which Peyer and Vermaelen (2009) use to capture the overreaction bad news, the main results still hold. Thus, my undervaluation hypothesis is not driven by this overreaction to bad information 'before' the repurchase announcement. The investors may also overreact the good news of repurchase and may push the stock price too high because past studies suggest the repurchase announcement as a good signal. This overreaction happens "at or after" repurchase date and may also cause the long-run significantly positive abnormal return in first few years. If this overreaction hypothesis for good news of repurchases holds, the abnormal return will reverse in subsequent years. However, I do not find the reversal effect of subsequent long-term return and also rule out this possibility of post overreaction.

This study adds to the repurchase literature in the following ways. First, this paper finds that the impact of investor sentiment on the share price helps to explain the mispricing of share repurchases and thus provides a new story for the undervaluation hypothesis of repurchases. Second, this paper is the first to incorporate the investor sentiment-based demand for shares into the issue of share repurchases, given that previous studies investigate the effect of investor sentiment on other corporate events such as IPOs and mergers and acquisitions.[4] Third, my results imply that investor sentiment helps to explain the return anomaly of share repurchases, especially when the factor model is used. This study thus appears to be related to that of Stambaugh et al. (2012), who suggest that the anomalies are driven by sentiment by investigating the net share issues and composite equity issues.[5] However, their paper discusses the time-series impact on anomaly, while my study

[3] Baker and Wurgler (2006) suggest that the investors tend to more greatly undervalue speculative stocks (such as small, young, high volatility, unprofitable, non-dividend-paying, extreme growth, and distressed stocks) than safety stocks when investor sentiment is pessimistic.

[4] For example, Rosen (2006) examines the mergers and investor sentiment and argues that managers may make more acquisitions when acquisitions are financed using stock from an optimistic market. Cornelli et al. (2006) investigate the IPO market and investor sentiment and find that optimistic investor sentiment is a predictor for first-day IPO prices and long-run price reversal only following over-optimism.

[5] These two measures are related to share repurchase. Net share issues are the changes in shares outstanding and composite equity issuance is the amount of equity a firm issues in exchange for cash or service. Thus, share repurchases lead to lower levels of net share issue and composite equity issuance.

focuses on the sensitivity to sentiment, which has cross-sectional variation. I target a corporate event, which is different from their investigation of an asset pricing issue.

The remainder of this paper is organized as follows. Section 2 describes the data, methodology, and hypothesis. Section 3 examines the relation between sensitivity to sentiment and the stock performance of repurchase firms and further examines whether the effect of the sentiment index is driven by other mispricing factors, such as book-to-market ratio and prior abnormal return. Section 4 illustrates the abnormal returns using factor model analyses. Section 5 includes discussions. Section 6 summarizes my findings.

2. Data and methodology

2.1. Data

I collect open market share repurchase announcements between January 1, 1990 and December 31, 2010 from the Securities Data Company's (SDC) Mergers and Acquisitions database.[6] I require that repurchase firms are included in the Center for Research in Security Prices (CRSP) and Compustat files. I exclude firms with share prices lower than $3 because the stock return of low price stocks may be skewed, biasing the long-run return estimations (Loughran and Ritter, 1996).[7] I also eliminate American Depository Receipts (ADRs), Real Estate Investment Trusts (REITs), and closed-end funds.[8] Repurchase firms are further required to have positive intended buyback ratios, size, assets, sales, and B/M ratio. The final sample consists of 6,448 repurchase announcements (for 3,137 firms).[9]

2.2. Sentiment index and sensitivity to sentiment

I use the sentiment index and orthogonalized sentiment index of Baker and Wurgler (2006) as the investor sentiment proxy for several reasons. First, their sentiment index is applied in many papers (Chung et al., 2012; Mian and Sankaraguruswamy, 2012; Stambaugh et al., 2012; Yu and Yuan, 2011).[10] Second, the index is publicly offered and easily obtained from Professor Jeffery Wurgler's website.[11] Several studies adopt other specific proxies for investor sentiment which are not as easily collected. For example, Tetlock (2007) suggests the measures of media content as a proxy for investor sentiment, while Kumar and Lee (2006) use the systematic correlation between retail investors' trades to represent investor sentiment. Third, the measure of Baker and Wurgler is roughly consistent with the fluctuations of historical account in sentiment such as bubbles and crashes. This approach using the macro concept can prevent the problem of complicated investor sentiment being difficult to summarize by a few selected biases in individual investor psychology such as overconfidence or conservatism, as seen in some papers.

Baker and Wurgler (2006) adopt six variables suggested in the literature and then use principal component analysis to create a measure of investor sentiment with U.S. data since 1962. These variables are closed-end fund discount, logarithm of the turnover ratio, number of IPOs, first-day return of IPOs, the share of equity issues relative to total issues, and dividend premium. Baker and Wurgler (2006) also construct an orthogonalized sentiment index ($sentiment_t^{\perp}$ hereafter) to isolate the sentiment component from the business cycle and macroeconomic conditions.[12] I adopt this sentiment index as my main method because the orthogonalized sentiment index is a clearer measure of the sentiment component. I also use the raw sentiment index of equation as a robustness check and obtain quantitatively similar results.

I use the sensitivity to sentiment to test my sentiment-driven undervaluation story. In this paper, I argue that a firm with high sensitivity to sentiment exhibits firm-specific undervaluation, which shows that investors have different sentiments toward firm specific information. However, I only have only the general investor sentiment index and do not have firm specific data for investor sentiment. In addition, according to Baker and Wurgler (2006), the sensitivity to sentiment toward firm specific information has a prediction similar to that of general sensitivity to sentiment.[13] Based on above discussion, I follow Baker and Wurgler (2006) to directly use the sentiment index into regression to capture the effect from the investor sentiment. Namely, I empirically use the sensitivity to general sentiment to replace the sensitivity to sentiment to firm specific information. The sensitivity to sentiment is the coefficient (b_i) of the following regression using 24 monthly returns in the pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment_{t-1}^{\perp} + u_{it}, \quad (1)$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. To estimate the regression coefficient, I restrict the test to firms having at least 24 monthly returns. The results remain unchanged whether I relax this restriction to 12 months or tighten it to 36.

When a firm is defined as having a high sensitivity to sentiment (b_i), it means that this firm tends to be mispriced more because this firm may be difficult to value or hard to arbitrage. Recall that undervaluation is a key purpose of repurchasing shares. Accordingly, I construct the following hypothesis to examine whether

[6] U.S. firms are not required to disclose the time period in which they plan to execute repurchase programs. Only an aggregate number of shares that will be bought back (but not authorized repurchased value) is announced, yet the firms can actually buy back more (or fewer) shares than the target repurchase ratio without punishment. U.S. firms are not required to disclose actual buyback status before 2004 (Ikenberry et al., 2000). At the end of 2003, the SEC amended Exchange Act Rule 10b-18, which requires all repurchase firms to disclose actual buyback status for repurchases in their annual and quarterly reports. Even though actual buyback information is disclosed since 2004, all actual buyback details are summarized with an aggregate number in quarterly or annual reports. I do not know the detailed volume or repurchase price for the date on which the firm actually buys back shares since even the date the firm actually buys back shares is unknown.

[7] Chan et al. (2004), Billett and Xue (2007), Peyer and Vermaelen (2009), Chen and Wang (2012) and Chen et al. (2015) all follow the suggestion of Loughran and Ritter (1996) to remove low price stocks in repurchase studies. I test different price thresholds and the results remain unchanged.

[8] Following Ikenberry et al. (1995), Chan et al. (2004), and Peyer and Vermaelen (2009), I include both financial and non-financial firms in the sample. However, the results are unchanged if I exclude financial firms (SIC code 60).

[9] In addition to the 6448 repurchase announcements, I also remove repeat repurchases in the announcement year or in the three-year post-buyback period because many firms engage in multiple repurchase announcements. From this reduced sample, I obtain similar results.

[10] The measures of investor sentiment from the investor surveys such as consumer confidence index, investors intelligence index and the University of Michigan consumer index are also usually adopted in some studies (Brown and Cliff, 2005; Fisher and Statman, 2000; Ho and Hung, 2009; Lee et al., 2002; Lemmon and Portniaguina, 2006). However, the consumer confidence index and the Michigan consumer index assess expectations about economy rather than the stock market.

[11] The raw and orthogonalized sentiment indices are publicly available on Professor Jeffery Wurgler's website: http://people.stern.nyu.edu/jwurgler/. I stop the sample selection at 2010 because investor sentiment index is available up to 2010 at his website. I appreciate Professor Wurgler's data support.

[12] For example, in general, firms will decide to issue an IPO when the business cycle is good.

[13] Baker and Wurgler (2006) posit that the mispricing comes from two channels: the cross-sectional variation in sentiment and the cross-sectional variation in arbitrage. The first channel considers the sentiment-based demand shocks vary across firms and thereby seems to view the investors as having different sentiment toward firm specific information. The second channel views investor sentiment as optimistic or pessimistic about the stocks in general. These indiscriminate waves of sentiment have greater effect on some stocks because their arbitrage tends to be particularly risky and costly. This second channel tends to consider the sensitivity to general sentiment. Further, Baker and Wurgler (2006) argue that, in practice, the two distinct channels have a similar effect because stocks that are difficult to arbitrage also tend to be the most difficult to value.

the undervaluation of repurchasing firms is driven by investor sentiment.

Hypothesis. If a firm with a higher sensitivity to sentiment buys back shares, its stock will be undervalued more prior to the repurchase and then its stock return will be higher after the repurchase.

2.3. Abnormal stock returns

I measure abnormal returns using two approaches: annualized BHAR and the Carhart (1997) four-factor model. First, I compute buy-and-hold return (BHR) following Ikenberry et al. (1995), Chan et al. (2004), and Chen and Wang (2012). BHR is a more straightforward return that investors can realize. Following the above mentioned papers, I compute BHAR as the sample firm BHR minus that of the size/book-to-market matching firms.[14] As suggested in Chen and Wang (2012), I annualize the BHAR because annualization reduces the skewness concerns raised in the literature (Barber and Lyon, 1997; Lyon et al., 1999).

The second method I use is the Carhart (1997) four-factor model because it is widely used in calculating abnormal return in the repurchase literature (Chen and Wang, 2012; Massa et al., 2007; Peyer and Vermaelen, 2009). The Carhart (1997) four-factor model is specified as follows:

$$R_{pt} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + sSMB_t + hHML_t + wWML_t + e_t. \quad (2)$$

R_{pt} is the return of repurchase firm portfolio and r_{ft} is the one-month T-bill rate in a given calendar month t from 1992 to 2008. r_m is the CRSP value-weighted index return, *SMB* is the small-firm portfolio return minus big-firm portfolio return, *HML* is the high book-to-market portfolio return minus low book-to-market portfolio return, and *WML* is the winner portfolio return minus loser portfolio return where winner and loser are identified by prior-year returns. For each month from 1992 to 2008, I form a calendar-time portfolio by including sample firms that have announced repurchase programs in any of the past 24 months.[15] The portfolio returns are computed by equal-weighted, log-value-weighted, and value-weighted portfolios. The intercept, α, is the average monthly abnormal return.

Finally, I add the sentiment index to the Carhart (1997) four-factor model model. If the sentiment index helps to explain the return of repurchase firms, then the abnormal return will be less significant or not significant after the incorporation of the sentiment index than the abnormal return of conventional factor models.

3. Post-buyback stock performance and sensitivity to sentiment

3.1. Summary statistics

Table 1 shows the summary statistics of my repurchase sample. Panel A of Table 1 presents the statistics of repurchase firms for the sample period. This Panel finds that firms on average buy back 6.76% of their shares outstanding. Average initial return is 1.71%, which is significant at the 1% confidence level. Previous papers suggest that repurchase firms experience lower BHRs than non-repurchase firms prior to the buyback-period (Ikenberry et al., 1995). Similarly, I find that the average one-year abnormal return of repurchase firms before the repurchase announcement date is −14.45%. All firm characteristics vary across years.

Panel B of Table 1 presents the summary statistics of repurchase firms in subgroups of sensitivity to sentiment. I divide the repurchase sample into 5 quintiles by sensitivity to sentiment. Quintile 1 (5) represents the lowest (highest) sensitivity to sentiment. Comparison of firms with different sensitivity to sentiment shows that repurchase firms in quintile 5 tend to be relatively small firms and value firms. Firms with smaller size and higher book-to-market ratio fit my contention that firms with high sensitivity to sentiment are prone to be mispriced. In addition, firms in quintile 5 do not have the highest book-to-market ratio. This result means that my undervaluation story is not driven by the book-to-market ratio. Further, the finding that all repurchase firms have short run abnormal return after repurchase announcement is consistent with the findings of previous studies (Chen and Wang, 2012; Ikenberry et al., 1995).

I also examine whether the higher sensitivity to sentiment is related to more mispricing using institutional investor holdings. Since institutional investors are more rational investors and individual investors are speculators (Barber et al., 2009; Odean, 1999), firms with more institutional investors may be less likely to be mispriced. Thus, I calculate the average institutional investor holding of these 5 groups around the repurchase announcement date and show the patterns in Fig. 1. I find that repurchase firms with higher sensitivity to sentiment have a lower proportion of shares held by institutional investors. This result seems to imply that firms with higher sensitivity to sentiment are more likely to be mispriced.

It is likely that repurchase stocks which are highly sensitive to sentiment may be illiquid, speculative, and hard to arbitrage stocks. Baker and Wurgler (2006) argue that some stocks that are defined as speculative small illiquid stocks are significantly affected by investor sentiment. In unreported results, I test this conjecture using the Amihud (2002) illiquidity measure and idiosyncratic volatility (Lam and Wei, 2011). I find that the average Amihud (2002) illiquidity measures of highest and lowest sensitivity to sentiment stocks are 0.0029 and 0.0025, respectively. Average idiosyncratic volatilities of highest and lowest sensitivity to sentiment stocks are 3.96 and 3.62, respectively. Therefore, consistent with Baker and Wurgler (2006), repurchase stocks with high sensitivity to sentiment are indeed illiquid, speculative, and accordingly hard to arbitrage.

3.2. Post-buyback abnormal return

In the summary statistics, I do not find a statistical difference in the post buyback 5-day abnormal return between high and low sensitivity to sentiment quintiles. There are two alternative explanations for this result: either sentiment does not affect repurchase valuation, or the market reaction is slow to realize the valuation. Therefore, I examine the long-run return after repurchases. Similar to Chan et al. (2010), I examine two-year returns after repurchases.

Table 2 shows the annualized BHARs for two years after the repurchase date. The overall sample shows that average annual return of repurchase firms is 1.51%, which is significant at the 1% confidence level. This is consistent with past repurchase papers. When I split repurchase firms into sensitivity to sentiment quintile groups, I find that repurchasers of quintile 4 and 5 significantly outperform their size/book-to-market benchmarks. Repurchase firms in quintile 5 have the highest BHAR, which is significantly positive. The mean abnormal return in this group is significant at 5.05%. In addition, repurchase firms in quintile 5 have significantly higher BHARs than firms in quintile 1. The difference in average abnormal

[14] To find potential matching firms, I form the potential pool by including those firms that do not announce repurchases in the previous five years. I look backward but not forward in finding the matching pool to avoid look-ahead bias. However, when I also exclude firms that have made repurchases in the past and future five years from the matching pool, I obtain similar results.

[15] To have complete two-year returns in post-buyback period, I remove repurchases from the first two years and last two years of my sample, as suggested by Chan et al. (2010). Even when I use the complete repurchase sample, the results are quantitatively similar.

Table 1
Summary statistics.

	N	Buyback ratio	Size	B/M	RD-to-Asset	5-day AR	Buy-and-hold prior return			Sensitivity-to-sentiment
							Sample	Match	AR	
Panel A: summary statistics sorted by years										
All	6448	0.0676	4601	1.4713	0.0242	0.0171***	0.0550	0.1994	−0.1445***	−0.0369
1990	3	0.0540	4993	3.3839	0.0305	0.0496*	−0.1480	−0.1000	−0.0480	0.1036
1991	3	0.2149	9825	0.6604	0.0095	0.0152	0.3003	0.4045	−0.1042***	−0.3000
1992	2	0.1205	206	0.6701	0.0058	0.0883**	0.0984	−0.0308	0.1291	−0.0882
1993	11	0.0461	1413	0.6140	0.0091	−0.0064	−0.0092	0.2020	−0.2112**	0.1126
1994	96	0.0651	2204	4.7068	0.0104	0.0062	0.0389	0.1059	−0.0671	−0.0240
1995	113	0.0584	1493	1.1020	0.0221	0.0146*	0.1004	0.2410	−0.1406***	−0.1934
1996	149	0.0694	1894	1.0556	0.0175	0.0132**	0.1029	0.3452	−0.2423***	0.0856
1997	461	0.0627	3273	1.4676	0.0289	0.0124**	0.1633	0.2392	−0.0759	−0.0014
1998	787	0.0682	2266	2.7105	0.0298	0.0243***	−0.0201	0.1074	−0.1276***	0.0603
1999	593	0.0710	2997	2.9943	0.0209	0.0246***	−0.0943	0.2504	−0.3448***	0.0664
2000	579	0.0727	3400	1.8028	0.0222	0.0208***	−0.0728	0.4030	−0.4758***	−0.0693
2001	537	0.0628	4749	1.2831	0.0235	0.0221***	0.0542	0.0462	0.0080***	−0.0210
2002	415	0.0635	5601	1.1735	0.0253	0.0273***	0.0847	0.0529	0.0319***	−0.0840
2003	351	0.0625	5742	0.8330	0.0206	0.0148***	0.1399	0.2599	−0.1200***	−0.0646
2004	434	0.0597	8313	1.3278	0.0250	0.0095***	0.2560	0.4832	−0.2272***	−0.1201
2005	496	0.0632	5807	0.4680	0.0220	0.0055	0.1120	0.2190	−0.1070***	−0.1328
2006	476	0.0697	6722	0.4827	0.0214	0.0104***	0.1220	0.2222	−0.1002***	0.0695
2007	272	0.0762	6381	0.4736	0.0217	0.0139***	0.0444	0.1533	−0.1089***	−0.1670
2008	297	0.0759	4156	0.7361	0.0301	0.0217***	−0.1677	−0.2238	0.0562***	0.1115
2009	199	0.0698	6078	0.7597	0.0272	0.0155***	0.0047	−0.0479	0.0526***	−0.2746
2010	174	0.0862	6605	0.5686	0.0303	0.0043	0.3508	0.5156	−0.1648***	−0.3013
Panel B: summary statistics sorted by sensitivity to sentiment										
Quintile 1	1290	0.0691	3518	1.4143	0.0390	0.0217***	0.0270	0.2065	−0.1795***	−0.2492
Quintile 2	1300	0.0678	5199	2.0673	0.0198	0.0149***	0.0517	0.1885	−0.1367***	−0.0920
Quintile 3	1297	0.0654	5639	1.0750	0.0164	0.0120***	0.0620	0.1648	−0.1028***	−0.0357
Quintile 4	1287	0.0693	4981	0.8812	0.0203	0.0170***	0.0486	0.2043	−0.1557***	0.0199
Quintile 5	1274	0.0665	3648	1.9206	0.0256	0.0200***	0.0859	0.2339	−0.1479***	0.1756

This table presents the summary statistics of share repurchases where Panels A and B show the mean of each variable by year and by sensitivity to sentiment, respectively. The sensitivity to sentiment is the regression coefficient (b_i) of the following regression using 24 monthly returns in the pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $Sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). *Buyback ratio* is the intended buyback ratio authorized by board of directors at the repurchase announcement date. *Size* is the stock price timing shares outstanding at the previous month end of the repurchase announcement date. I convert *size* to 2010 dollars using the consumer price index. *B/M* is the book-to-market ratio, which is measured as the book equity value divided by *size*. *RD-to-asset* is the R&D capital expenditure scaled by book assets where missing *RD-to-asset* ratios are replaced by zero. *5-day AR* is the five-day (−2, +2) buy-and-hold return of the repurchase firm minus the corresponding buy-and-hold return of size/book-to-market matching firms. *Buy-and-hold prior return* is average 252-day buy-and-hold returns prior to the repurchase announcement date. *Sample* and *match* represent the buy-and-hold prior return of the repurchase firm and the size/book-to-market matching firms, respectively. *AR* is the abnormal return, which is the prior return difference between the sample firm and matching firms. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile.*, **, and *** represent the statistical significance at the 10%, 5% and 1% levels, respectively.

return between these two groups is 4.1%, which is significant. The group of quintile 5 has the highest sensitivity to sentiment. Thus, firms with higher sensitivity to sentiment may be undervalued more prior to repurchase and experience higher BHAR return after repurchase.

I find no abnormal return difference at the repurchase announcement date but uncover a two-year abnormal return spread between high and low sensitivity to sentiment groups. Thus, the horizon for the holding period returns in between may be of interest. In unreported results, I find that there is an abnormal return spread between the high and low sensitivity to sentiment subgroups beginning with the third quarter, meaning that investors are sometimes slow in differentiating different types of repurchase stocks in the short run. This finding is consistent with the findings of several repurchase papers, such as Ikenberry et al. (1995) and Chan et al. (2010), who find no effects of book-to-market and discretionary accruals on short-run abnormal returns around repurchase announcement dates.

Fig. 2 shows the relationship between post-buyback BHARs and orthogonalized sentiment in calendar years. The solid line represents the orthogonalized sentiment index. The dashed line represents the annualized post-buyback BHARs of the hedge portfolio, which consists of the long position of repurchase stocks in quintile 5 and the short position of repurchase stocks in quintile 1. This dashed line moves in the opposite direction of the solid line except during the sub-period around the internet bubble burst (years 2001 and 2002) and the global financial crisis (year 2008). The decrease in the sentiment index means that investors are pessimistic about the value of the firm. The higher post-buyback BHARs imply greater undervaluation of firms prior to the repurchase announcement. My finding implies that repurchase firms are more sensitive to the sentiment index during bearish times. These high sensitivity to sentiment firms should be undervalued more and have higher post-buyback BHARs.[16] In addition, this finding appears to be consistent with of the findings of Mian and Sankaraguruswamy (2012) that the market overreacts to bad news and underreacts to good news during bearish times, thus causing the underpricing of stocks.

3.3. Post-buyback abnormal return and other mispricing measures

In this subsection, I perform tests on other mispricing variables in the repurchase literature to determine whether they affect my findings. Studies suggest that B/M and prior abnormal return are

[16] By contrast, during the bullish times, the opposite relationship between the dashed line and the solid line is less significant, implying that the influence of sensitivity to sentiment for bad news may be greater than for good news.

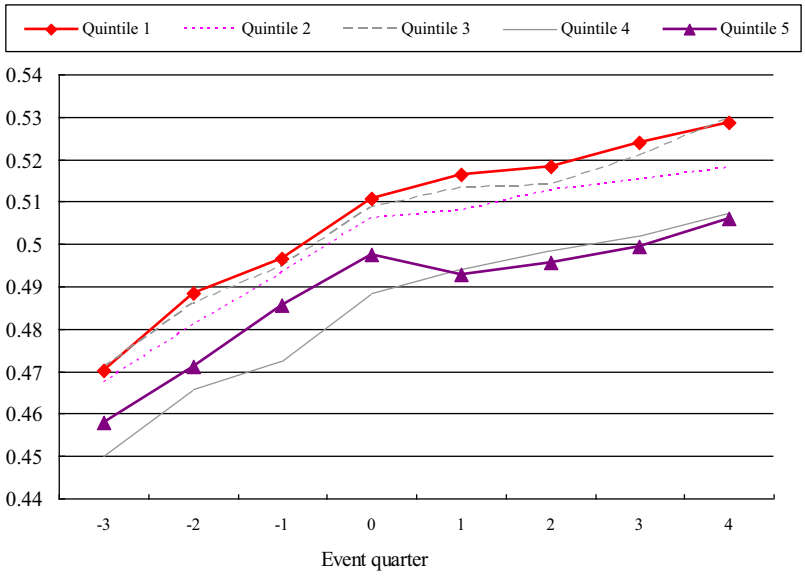

Fig. 1. Institutional investor holdings around the repurchase announcement date. This figure presents the proportion of institutional investor holdings around the repurchase announcement date. The information of institutional investor holdings is obtained from Thomson Financial. For quarter 0, I report the shares held by institutional investors at the quarter before the repurchase announcement date. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile.

Table 2
Buy-and-hold stock return.

Sensitivity-to-Sentiment Rank	*N*	Buy-and-hold return		Abnormal return
		Sample	Match	
All	6448	0.1660	0.1509	0.0151
		(37.07)	(40.49)	(2.90)
Quintile 1	1290	0.1438	0.1342	0.0095
		(13.60)	(15.33)	(0.81)
Quintile 2	1300	0.1318	0.1487	−0.0168
		(15.40)	(18.14)	(−1.56)
Quintile 3	1297	0.1656	0.1533	0.0123
		(17.45)	(18.53)	(1.10)
Quintile 4	1287	0.1795	0.1587	0.0208
		(19.47)	(19.72)	(1.86)
Quintile 5	1274	0.2103	0.1598	0.0505
		(17.75)	(19.07)	(3.80)
Quintile 1		−0.0666	−0.0256	−0.0410
−Quintile 5		(−4.19)	(−2.11)	(−2.32)

This table presents the mean of annualized buy-and-hold returns for the two years after the repurchase date sorted by sensitivity to sentiment quintiles. The sensitivity to sentiment is the coefficient (b_i) of following regression by using 24 monthly returns in pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $Sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). *Buy-and-hold return* is the average of buy-and-hold returns over two years in the post-buyback period where I define a trading year as 252 days. *Sample* and *match* represent the annualized buy-and-hold return of the repurchase firm and the size/book-to-market matching firms, respectively. *Abnormal return* is the return difference between the sample firm and matching firms. I winsorize stock returns at top–bottom 1% in distribution. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are *t*-statistics.

two factors that capture undervaluation. Ikenberry et al. (1995)) and Chan et al. (2004) propose that repurchase firms with higher book-to-market ratio tend to be undervalued more. Peyer and Vermaelen (2009) adopt the pre-buyback-period stock return as a proxy for the undervaluation of the repurchase firm where they argue that investors may overreact to bad news before the repurchase date, leading to undervaluation of the repurchase firm. All of these papers suggest mispricing for repurchase firms and find that more undervalued firms experience higher post-buyback long run abnormal returns. Therefore, I need to examine whether my story still works after controlling for the B/M ratio and prior abnormal return.

Table 3 presents that average post-buyback BHR sorted by B/M ratio and sensitivity-to-sentiment (Panel A), and sorted by prior abnormal return and sensitivity to sentiment (Panel B). Subsamples are sorted by medians of the B/M ratio and prior abnormal return. In panel A, the group of high B/M ratio (high undervalued firms) repurchase firms in quintile 5 have significantly positive and high post-buyback BHARs. In addition, for this high B/M group, firms in quintile 5 have significantly higher BHARs than firms in quintile 1. For the group with low B/M ratios, repurchase firms in quintile 5 still have the highest BHARs post-repurchase, which are significantly positive. Thus, even after controlling for the

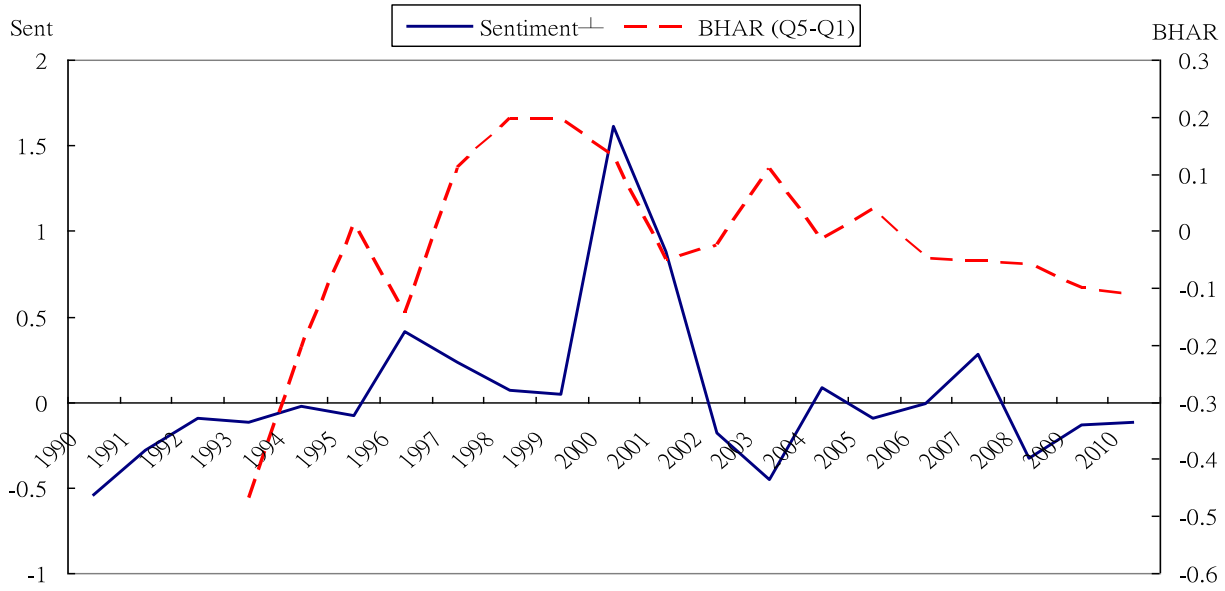

Fig. 2. Sentiment index and buy-and-hold abnormal return. This figure presents the relationship between annualized post-buyback BHARs of hedge portfolio and orthogonalized sentiment index in calendar years. The hedge portfolio consists of the long position of repurchase stocks with quintile 5 and the short position of repurchase stocks with quintile 1. *Sentiment*$^{\perp}$ is the orthogonalized sentiment index in Baker and Wurgler (2006). Annualized BHR is the average of BHRs over two years in the post-buyback period where I define a trading year as 252 days. BHAR is the BHR of sample firm minus BHR of matching firm that controls for size and book-to-market matching firms, respectively.

undervaluation of the B/M ratio, the sensitivity to sentiment still affects BHARs.

Panel B of Table 3 shows the results after controlling for prior abnormal return. The group with low prior abnormal return tends to be undervalued firms. For the group with low prior abnormal return, repurchase firms in quintile 5 still earn the highest post-buyback BHARs, which are significantly positive. In this group, firms in quintile 5 have significantly higher BHARs than firms in quintile 1. In addition, the group with high prior abnormal return has similar results. Thus, even considering the undervaluation from the prior abnormal return, the sensitivity to sentiment still influences BHARs. In short, the B/M ratio and prior abnormal return cannot explain the impact of the sensitivity to sentiment on the repurchase firms.

As a robustness check, I identify potential undervalued repurchase firms with the highest B/M ratio, lowest prior return, or highest sensitivity to sentiment. I find that the probability of being undervalued by the sensitivity to investor sentiment is almost independent of being undervalued by B/M and prior return, indicating that B/M and prior return cannot explain the effect of the sensitivity to sentiment.[17] This finding also seems to imply that B/M, prior abnormal returns and the sensitivity-to-sentiment capture different types of mispricing. In previous studies, the undervaluation by B/M ratio implies that investors put too less weight on value stocks (Ikenberry et al., 1995) while the undervaluation by prior abnormal return indicates that investors extrapolate the past performance too much (Peyer and Vermaelen, 2009). These two measures capture different styles of mispricing information and both styles are related to investor irrationality. In addition to investor irrationality, the sensitivity-to-sentiment in this paper is also related with the market friction. Both rational and irrational investors are assumed to trade stocks in the capital market. While irrational investors may trade stocks away from the true value, rational investors should arbitrage those mispriced stocks and remove the market inefficiency. However, when the market has friction which prevent rational investors from arbitraging well, the trading of irrational investors may result in mispricing. Thus, as I argued in Section 5.2, the stocks that are more sensitive to sentiment are more restrict in the arbitrage cost and/or are hard to value, which cause Shleifer and Vishny (1997) style mispricing.[18] The different mispricing proxies capture different mispricing information through different channels.[19] The contribution of this paper is that the sensitivity-to-sentiment can capture a mispricing information style different from that of B/M and prior abnormal returns. In unreported results, I also use firm size, research and development (R&D), and analyst coverage as proxies for the degree of information asymmetry to explore whether information asymmetry influences the sentiment effect.[20] When the degree of information asymmetry of a firm is high, the stock of the firm is more likely to be mispriced. I find that the post-buyback BHAR of quintile 5 is significantly higher than that of quintile 1, especially when the firms are small firms or when the firms have R&D expenditure. In addition, I find that the post-buyback BHAR of quintile 5 is significantly higher than that of quintile 1 for firms with low analyst coverage.[21] These results imply that the higher information asymmetry from small size, high R&D expenditure and/or low analyst coverage strengthens the sentiment-driven mispricing effect.

[17] I appreciate this suggestion from an anonymous referee.

[18] Shleifer and Vishny (1997) put forth the mispricing hypothesis from the limits to arbitrage, showing that specialized arbitrage may not fully return the stock price to its fundamental value in some circumstances.

[19] If these three measures capture the same or similar information, one measure can be fully replaced to another. Thus, these three measures contribute the research to explain the undervaluation by catching different mispricing information.

[20] Aboody and Lev (2000) suggest that firms with R&D exhibit a high degree of information asymmetry. Babenko et al. (2012) and Chan et al. (2013) suggest that information asymmetry is higher for firms with low analyst coverage.

[21] When firms do not spend on R&D, the difference of BHAR between quintile 5 and quintile 1 is smaller and less significant. By contrast, when the firms have high analyst coverage, the difference in BHAR between quintile 5 and quintile 1 is not significant.

Table 3
Buy-and-hold stock return: Tests of undervaluation.

Sensitivity-to-sentiment rank	N	Buy-and-hold return		Abnormal return	N	Buy-and-hold return		Abnormal return
		Sample	Match			Sample	Match	
Panel A: sort by B/M ratio								
		High B/M ratio				Low B/M ratio		
Quintile 1	627	0.1602	0.1591	0.0011	663	0.1315	0.1121	0.0194
		(10.18)	(11.67)	(0.06)		(8.90)	(9.84)	(1.19)
Quintile 2	660	0.1409	0.1727	−0.0319	640	0.1232	0.1243	−0.0011
		(12.07)	(14.11)	(−2.05)		(9.73)	(11.47)	(−0.07)
Quintile 3	673	0.2014	0.1701	0.0313	624	0.1299	0.1395	−0.0096
		(13.94)	(13.51)	(1.78)		(10.23)	(11.80)	(−0.64)
Quintile 4	640	0.1921	0.1707	0.0215	647	0.1659	0.1482	0.0178
		(16.68)	(13.27)	(1.32)		(11.72)	(13.92)	(1.11)
Quintile 5	624	0.2462	0.1851	0.0611	650	0.1780	0.1372	0.0408
		(13.81)	(15.07)	(2.99)		(11.17)	(11.80)	(2.33)
Quintile 1		−0.0860	−0.0260	−0.0600		−0.0465	−0.0250	−0.0214
-Quintile 5		(−3.62)	(−1.42)	(−2.22)		(−2.14)	(−1.54)	(−0.90)
Panel B: sort by prior abnormal return								
		High prior abnormal return				Low prior abnormal return		
Quintile 1	591	0.1342	0.1521	−0.0179	699	0.1557	0.1186	0.0371
		(9.51)	(11.94)	(−1.08)		(9.69)	(9.90)	(2.18)
Quintile 2	671	0.1348	0.1648	−0.0301	629	0.1316	0.1344	−0.0028
		(11.57)	(14.20)	(−2.03)		(10.09)	(11.16)	(−0.17)
Quintile 3	691	0.1476	0.1473	0.0003	606	0.1888	0.1671	0.0217
		(11.84)	(14.46)	(0.02)		(12.66)	(11.31)	(1.15)
Quintile 4	656	0.1582	0.1571	0.0011	631	0.2005	0.1657	0.0348
		(13.37)	(13.89)	(0.07)		(14.29)	(12.84)	(1.99)
Quintile 5	615	0.1888	0.1642	0.0246	659	0.2350	0.1594	0.0756
		(12.95)	(13.43)	(1.41)		(12.34)	(13.24)	(3.67)
Quintile 1		−0.0547	−0.0121	−0.0425		−0.0793	−0.0408	−0.0385
-Quintile 5		(−2.69)	(−0.69)	(−1.77)		(−3.18)	(−2.40)	(−1.44)

This table presents that average post-buyback buy-and-hold returns incorporating the B/M ratio and prior abnormal return into the original sensitivity to sentiment quintiles. The sensitivity to sentiment is the coefficient (b_i) of following regression by using 24 monthly returns in the pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $Sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). Panel A shows the results sorted by sensitivity to sentiment and B/M ratio, which B/M ratio is measured as the book equity value divided by firm size. 'High B/M ratio' ('Low B/M ratio') indicates repurchase firms with B/M ratios higher (lower) than the median. Panel B shows the results sorted by sensitivity to sentiment and prior abnormal return. The prior abnormal return is the 252-day buy-and-hold return difference between the repurchase firm and size/book-to-market matching firms prior to the repurchase announcement date. 'High prior abnormal return' (Low prior abnormal return') indicates repurchase firms with prior abnormal return higher (lower) than the median. *Buy-and-hold return* is the average of buy-and-hold returns over two years in the post-buyback period where I define a trading year as 252 days. *Sample* and *match* represent the annualized buy-and-hold return of the repurchase firm and the size/book-to-market matching firms, respectively. *Abnormal return* is the return difference between the sample firm and matching firms. I winsorize stock returns at top–bottom 1% in distribution. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are *t*-statistics.

3.4. Post-buyback abnormal return regression

Table 4 presents the regression analyses of post-buyback BHAR on sensitivity to sentiment and other control variables. The dependent variable is the annualized BHAR for two years after repurchase announcement. Models 1 to 3 respectively add three mispricing variables (namely, the sensitivity to sentiment, B/M ratio, and prior abnormal return) to the regression. The coefficients of sensitivity to sentiment and B/M are both significantly positive, while the coefficient of prior abnormal return is significantly negative. These results are consistent with the economic implication that more undervalued firms experience higher post-buyback BHARs. In Model 4, I put all mispricing variables into the regression, and find that the effect of sensitivity to sentiment remains valid after controlling for B/M and prior abnormal returns. This result is consistent with the findings in Table 3.

Model 5 controls for the variables such as buyback ratio, size, HH index (Herfindal Hirschman index), DA (discretionary accruals), high KZ dummy (Kaplan and Zingales index) and illiq (Amihud (2002) illiquidity measure). The definitions of these variables are shown in Table 4. I incorporate these variables into the regression because they are factors that may relate to repurchase valuation (Chan et al., 2004, 2010; Chen and Wang, 2012; Gong et al., 2008; Massa et al., 2007). *Size*, *buyback ratio*, and *illiq* also capture potential liquidity cost, inelastic demand curves, and information effects.[22] The effect of sensitivity to sentiment is unchanged even when more variables are controlled for.

In Model 6, I consider the influence of asymmetric information. Lower analyst coverage means greater information asymmetry.[23] I input analyst coverage and the interaction term over sensitivity to sentiment with analyst coverage (i.e. *sensitivity to sentiment* × *ana-*

[22] Kraus and Stoll (1972) and Holthausen et al. (1987) investigate stock prices following large block trades. Holthausen et al. (1987) and Holthausen et al. (1990) suggest that negative mean price effects follow seller initiated block trades and positive effects follow buyer initiated block trades. Therefore, these results are attributed to liquidity costs (the cost/reward of finding a buyer/seller of a large block), inelastic demand curves (lack of close substitutes), and information effects (whereby the potential identity of the counterparties). I thank an anonymous referee for this comment.

[23] The independent variable, analyst coverage, could be endogenous because firms followed by lower analyst coverage tend to be small and illiquid stocks. I instrument for analyst coverage by firm size and Amihud (2002) illiquidity, and perform two-stage least squares analysis. The results are quantitative unchanged. I am grateful to an anonymous referee for pointing this out for me.

Table 4
Buy-and-hold abnormal return regression.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.0209	0.0086	0.0089	0.0039	0.0076	0.0158
	(3.02)	(1.12)	(1.46)	(0.48)	(0.41)	(0.77)
Sensitivity to sentiment	0.0984			0.0972	0.1968	0.2705
	(2.42)			(2.39)	(3.29)	(3.60)
B/M		0.0122		0.0117	0.0015	0.0019
		(2.00)		(1.91)	(0.17)	(0.21)
Prior abnormal return			−0.0594	−0.0595	−0.0659	−0.0662
			(−4.32)	(−4.33)	(−3.41)	(−3.43)
Buyback ratio					0.4122	0.3994
					(2.39)	(2.30)
Size					−0.0007	−0.0006
					(−3.33)	(−2.74)
HH index					−0.0384	−0.0393
					(−1.05)	(−1.07)
DA					−0.5728	−0.5685
					(−3.88)	(−3.86)
High KZ dummy					−0.0757	−0.0747
					(−2.25)	(−2.22)
Illiq (x 10^3)					0.4248	0.4275
					(2.04)	(2.07)
Analyst coverage						−0.0014
						(−1.26)
Sensitivity to sentiment ×analyst coverage						−0.0127
						(−2.01)
Adj. R-sq	0.0011	0.0003	0.0034	0.0048	0.0178	0.0182
N	6448	6448	6448	6448	3567	3567

This table presents the regression analysis of buy-and-hold abnormal returns in the post-buyback period. The dependent variable is the annualized buy-and-hold abnormal returns over two years in the post-buyback period where I define a trading year as 252 days. *Sensitivity to sentiment* is the coefficient (b_i) of following regression using 24 monthly returns in the pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $Sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). *B/M* is the book-to-market ratio, which is measured as the book equity value divided by firm size. *Size* is the stock price timing shares outstanding at the previous month end of the repurchase announcement date. I convert *size* to 2010 dollars using the consumer price index. *Prior abnormal return* is 252-day buy-and-hold return difference between the repurchase firm and size/book-to-market matching firms prior to the repurchase announcement date. *Buyback ratio* is the intended buyback ratio authorized by board of directors at the repurchase announcement date. *HH index* is the sum of squared market shares in three-digit Standard Industrial Classification industry. *DA* is the discretionary accruals defined in Chan et al. (2010). *High KZ dummy* is the financial constraint dummy where the dummy is equal to one if a firm has a Kaplan and Zingales (1997) index classified in the largest quintile. *Illiq* is the Amihud (2002) illiquidity measure, which is the time series average of the absolute value of daily returns divided by the daily trading volume using past one-year data ending at June of year $t+1$: $ILLIQ_{i,t+1} = 1/D_{i,t+1}\sum_{d=1}^{D_{i,t+1}} |R_{i,t+1,d}|/VOLD_{i,t+1,d}$, in which, $R_{i,t+1,d}$ is the return on stock i on day d of year $t+1$, and $VOLD_{i,t+1,d}$ is the daily volume in dollars. We halve the trading volume for stocks listed in Nasdaq exchange. *Analyst coverage* is the number of analysts following a firm before the repurchase announcement date where I obtain the analyst coverage from I/B/E/S database. Numbers in the parentheses are *t*-statistics with heteroskedasticity-consistent standard errors (White, 1980).

lyst coverage) into Model 6. The coefficient of analyst coverage is negative. This result implies that repurchase firms with more serious information asymmetry (i.e. low analyst coverage) tend to be undervalued and thus earn higher post abnormal return. In addition, the coefficient of this interaction term is negative and significant, which implies that firms with high sensitivity to sentiment and low analyst coverage tend to be undervalued more and thus earn higher post-buyback abnormal return.[24] Again, these findings are consistent with the implication that higher information asymmetry strengthens the sentiment-driven mispricing effect.

Next, I consider potential self-selection issue in this paper. The managers of firms may decide when to buy back shares, and then do so for a specific reason (e.g. previous undervaluation). Accordingly, a Heckman two-stage regression analysis may be used to address this concern where the first stage regression is whether to carry out the buyback decision (whether to repurchase) and the second stage regression is designed for post-buyback performance regression. In the first stage regression, I regress the buyback dummy on repurchase determinants, including firm size, B/M, prior one-year return (by skipping one month), HH index, DA, debt ratio, and unionization rate (the percentage of labor in labor unions in an industry, defined as in Chen et al. (2015). These determinants are documented as repurchase decision factors in the repurchase literature (Chen et al., 2015; Dittmar, 2000; Gong et al., 2008; Massa et al., 2007). In the second stage regression, I perform a BHAR regression as in Table 4.

Table 5 presents the Heckman two-stage regression analysis results. Controlling for potential self-selection issue, the sensitivity to sentiment in the second stage regression remains positive and significant with the slope ranging from 0.24 to 0.41. In Model 3, *sensitivity to sentiment* × *analyst coverage* is negative and significant, which is consistent with previous results. In the first stage regression, I find the coefficients of *size* and *B/M* are positive and significant, consistent with the finding of Dittmar (2000), whereas coefficients of prior abnormal return, HH index, debt ratio, and unionization rate are negative and significant, consistent with Dittmar (2000), Massa et al. (2007), and Chen et al. (2015).

4. Post-buyback stock performance upon factor models

Anomalies relating to corporate events may be eliminated when we compute abnormal returns using factor models (Fama, 1998;

[24] I also use R&D intensity as proxy for the degree of information asymmetry. The interaction term over sensitivity-to-sentiment with R&D intensity is significantly positive. Thus, using R&D intensity as an alternative information asymmetry proxy yields similar results.

Table 5
Heckman two-stage regression analysis for buy-and-hold abnormal returns.

	Model 1	Model 2	Model 3
Stage 2: buy-and-hold abnormal return regression			
Intercept	−0.0024	0.0801	0.1054
	(−0.03)	(0.92)	(1.09)
Sensitivity to sentiment	0.2407	0.2796	0.4086
	(4.31)	(4.44)	(4.78)
B/M	0.0054	0.0031	0.0034
	(0.51)	(0.26)	(0.29)
Prior abnormal return	−0.0534	−0.0613	−0.0621
	(−2.74)	(−2.86)	(−2.90)
Buyback ratio		0.4353	0.4263
		(1.84)	(1.80)
Size		(0.00)	(0.00)
		(−1.66)	(−1.51)
HH index		−0.0849	−0.0838
		(−1.37)	(−1.35)
DA		−0.5092	−0.5104
		(−3.82)	(−3.83)
High KZ dummy		−0.0534	−0.0494
		(−0.68)	(−0.63)
Illiq ($\times 10^3$)		0.2749	0.2820
		(0.81)	(0.83)
Analyst coverage			−0.0019
			(−1.07)
Sensitivity to sentiment			−0.0213
×analyst coverage			(−2.24)
Sigma	0.5361	0.5324	0.5322
	(74.42)	(66.33)	(64.67)
N	6448	3567	3567
Stage 1: Logit regression for repurchase decision			
Intercept	−3.3137	−3.3257	−3.3249
	(−42.34)	(−39.67)	(−39.66)
Size	0.1503	0.1477	0.1476
	(27.01)	(24.54)	(24.53)
B/M	0.0906	0.1256	0.1251
	(4.38)	(5.85)	(5.82)
Prior abnormal return	−0.0950	−0.1004	−0.1005
	(−6.52)	(−6.34)	(−6.35)
HH index	(−0.17)	(−0.16)	(−0.16)
	(−3.05)	(−2.72)	(−2.72)
DA	−0.0088	0.0051	0.0044
	(−0.09)	(0.05)	(0.04)
Debt ratio	−0.1946	−0.7429	−0.7434
	(−6.59)	(−13.32)	(−13.33)
Unionization rate	−1.2717	−1.0060	−1.0056
	(−12.89)	(−9.46)	(−9.45)
Rho	0.0381	−0.0549	−0.0696
	(0.50)	(−0.66)	(−0.79)
N	43,818	43,818	43,818
Log-likelihood	−12,354	−10,525	−10,522

This table presents the Heckman two-stage regression analysis of post-buyback buy-and-hold abnormal returns. In the first stage, I perform a logit regression by regressing buyback dummy (equal to one if a firm announces repurchase in a given year; zero otherwise) on repurchase determinants for whole listed firms. In the second stage, I perform buy-and-hold abnormal return regression for repurchase sample. The dependent variable of the second stage regression is the annualized buy-and-hold abnormal returns over two years in the post-buyback period where I define a trading year as 252 days.
Sensitivity to sentiment is the coefficient (b_i) of following regression using 24 monthly returns in the pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $Sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). *B/M* is the book-to-market ratio, which is measured as the book equity value divided by firm size. *Size* is the stock price timing shares outstanding at the previous month end of the repurchase announcement date. I convert *size* to 2010 dollars using the consumer price index. *Prior abnormal return* is 252-day buy-and-hold return difference between the repurchase firm and size/book-to-market matching firms prior to the repurchase announcement date. *Buyback ratio* is the intended buyback ratio authorized by board of directors at the repurchase announcement date. *HH index* is the sum of squared market shares in three-digit Standard Industrial Classification industry. *DA* is the discretionary accruals defined in Chan et al. (2010). *High KZ dummy* is the financial constraint dummy where the dummy is equal to one if a firm has a Kaplan and Zingales (1997) index classified in the largest quintile. *Illiq* is the Amihud (2002) illiquidity measure, which is the time series average of the absolute value of daily returns divided by the daily trading volume using past one-year data ending at June of year $t+1$: $ILLIQ_{i,t+1} = 1/D_{i,t+1}\sum_{d=1}^{D_{i,t+1}} |R_{i,t+1,d}|/VOLD_{i,t+1,d}$, in which, $R_{i,t+1,d}$ is the return on stock i on day d of year t + 1, and $VOLD_{i,t+1,d}$ is the daily volume in dollars. We halve the trading volume for stocks listed in Nasdaq exchange. *Analyst coverage* is the number of analysts following a firm before the repurchase announcement date where I obtain the analyst coverage from I/B/E/S database. *Debt ratio* is the sum of long-term and short-term debts divided by book asset. *Unionization rate* is defined in Chen et al. (2015) and equal to the percentage of workers in a three-digit Census Industry Classification (CIC) industry for the year prior to the repurchase who are represented by labor unions in collective bargaining agreements with firms. Numbers in the parentheses are *t*-statistics.

Lyon et al., 1999). Thus, in this section, I use the Carhart (1997) four-factor model to calculate abnormal returns because it is widely applied in the repurchase literature. Moreover, for robustness, I also compute the abnormal return using Fama and French (1993) three-factor model and the Ibbotson's RATS technique with the Fama and French (1993) three-factor setting.

4.1. Carhart four-factor model

Table 6 presents the average monthly abnormal returns of the Carhart (1997) four-factor model. Portfolio return can be calculated by the equal-weighted, value-weighted, and log-value-weighted methods. All repurchase firms experience significantly positive abnormal return after repurchases for these three measures of portfolio return. This result is similar to previous findings.[25] Dividing the repurchase firms into the five quintiles of sensitivity to sentiment, abnormal returns of the lowest sensitivity to sentiment subgroup are not significant. By contrast, the abnormal returns of the highest sensitivity to sentiment quintile are positive and range between 0.29% and 0.38%, which are significant at the 10% confidence level or better. These results also show that repurchase firms with high sensitivity to sentiment have high post abnormal returns.[26]

Does the insignificant abnormal return on the value weighted portfolio in Table 6 influence the conclusion? Loughran and Ritter (2000) argue that misvaluations are greater among small firms than among large firms and conclude that equal-weighted scheme, which models the small stocks with larger weight, is better in detecting abnormal returns than the value-weighted scheme in the factor model. Further, using simulation, Loughran and Ritter (2000) find the value-weighted methodology has low power to find abnormal performance for repurchase events. In addition, Fama and French (2008) also argue that value-weighted return can be dominated by a few large-firm stocks, resulting in unrepresentative result for the anomaly. Thus, the insignificant abnormal return on the value-weighted portfolio may be driven by a few large firms. To prove this conjecture, I remove the 67 largest firms with a firm size larger than 75 billion (roughly the top 1% of the firm size in sample distribution) and re-run the Carhart's four-factor value-weighted abnormal return. After excluding these large firms, the

[25] The abnormal returns in all repurchase firms are significantly positive. However, compared with abnormal returns found in previous papers, the magnitude of the abnormal return falls but remains significant at the 10% confidence level. The return becomes smaller because the sample of this paper includes the 2008 financial crisis. Although not reported in the paper, when I focus on the pre-2008 subsample, the magnitude of post-buyback abnormal return is quite similar to the findings in the repurchase literature.

[26] In unreported results, for robustness, I also compute the abnormal returns by two methods. First, I use the Fama and French (1993) three-factor model. Second, I follow Peyer and Vermaelen (2009) to adopt the RATS approach of Ibbotson (1975), which accommodates the time-varying risk in computing abnormal returns associated with Fama and French three-factor setting. Similarly, both these results show that repurchase firms with higher sensitivity to sentiment earn higher abnormal return.

Table 6
Abnormal stock return by the Carhart (1997) four-factor model.

Sensitivity-to-sentiment rank	Equal-weighted					Log-value-weighted					Value-weighted				
	α	β	s	h	w	α	β	s	h	w	α	β	s	h	w
All	0.2621	0.7099	0.3357	0.4763	−0.0651	0.2632	0.7358	0.3161	0.4775	−0.0597	0.1725	0.8062	−0.1331	0.2494	−0.0029
	(2.28)	(25.35)	(9.44)	(13.18)	(−5.61)	(2.36)	(27.19)	(8.70)	(12.65)	(−5.14)	(1.89)	(31.33)	(−4.69)	(4.75)	(−0.24)
Quintile 1	0.0820	0.7208	0.3708	0.3488	−0.1307	0.0536	0.7532	0.3468	0.3414	−0.1328	0.2362	0.9504	0.0339	0.1507	−0.1239
	(0.66)	(29.74)	(8.57)	(7.96)	(−8.19)	(0.39)	(31.08)	(7.60)	(6.99)	(−7.70)	(1.35)	(20.86)	(0.51)	(1.66)	(−4.45)
Quintile 2	0.2377	0.7195	0.3243	0.5453	−0.0747	0.1570	0.7444	0.3081	0.5625	−0.0739	0.1558	0.8062	−0.2139	0.2735	−0.0206
	(1.69)	(24.63)	(8.22)	(14.34)	(−5.39)	(1.11)	(26.88)	(7.84)	(14.40)	(−5.59)	(0.97)	(22.07)	(−4.89)	(4.55)	(−1.51)
Quintile 3	0.2276	0.7002	0.3055	0.5554	−0.0526	0.2294	0.7263	0.2746	0.5631	−0.0453	−0.0174	0.8413	−0.1520	0.3522	0.0364
	(1.62)	(19.77)	(8.40)	(12.38)	(−3.79)	(1.49)	(19.95)	(7.27)	(12.00)	(−3.45)	(−0.10)	(17.86)	(−2.64)	(4.95)	(2.15)
Quintile 4	0.3381	0.6909	0.2899	0.5154	−0.0400	0.3099	0.7085	0.2671	0.5360	−0.0411	0.3042	0.7502	−0.1341	0.4015	0.0267
	(2.46)	(19.62)	(6.95)	(11.17)	(−3.16)	(2.12)	(19.27)	(6.42)	(11.33)	(−3.65)	(1.67)	(13.95)	(−3.27)	(5.52)	(1.03)
Quintile 5	0.3112	0.7138	0.4223	0.4303	−0.0351	0.2869	0.7333	0.4180	0.4458	−0.0305	0.3848	0.7713	−0.0051	0.1126	0.0134
	(2.10)	(15.52)	(9.36)	(8.63)	(−2.39)	(1.82)	(15.53)	(8.78)	(8.54)	(−2.05)	(1.92)	(15.74)	(−0.08)	(1.18)	(0.54)
Quintile 1	−0.2973	0.0427	−0.0843	−0.0961	−0.0941	−0.3480	0.0650	−0.0861	−0.0890	−0.0996	−0.3919	0.2028	0.0158	0.0026	−0.1377
−Quintile 5	(−1.83)	(0.77)	(−1.74)	(−1.48)	(−5.89)	(−2.00)	(1.04)	(−1.64)	(−1.27)	(−5.99)	(−1.35)	(2.08)	(0.18)	(0.03)	(−5.23)

This table presents the average monthly abnormal return for the two years after the repurchase announcement date. The Carhart (1997) four-factor model is specified as follows:

$$R_{pt} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + sSMB_t + hHML_t + wWML_t + e_t.$$

R_{pt} is the repurchase firm portfolio return and r_{ft} is the one-month T-bill rate in a given calendar month t from 1992 to 2008. r_m is the CRSP value-weighted index return, *SMB* is the small-firm portfolio return minus big-firm portfolio return, *HML* is the high book-to-market portfolio return minus low book-to-market portfolio return, and *WML* is the winner portfolio return minus loser portfolio return where winner and loser are identified by prior-year returns. For each month from 1992 to 2008, I form a calendar-time portfolio by including sample firms that have announced repurchase programs in any of the past 24 months. The portfolio returns are computed by equal-weighted, log-value-weighted or value-weighted portfolio return. *Sensitivity to sentiment* is the coefficient (b_i) of following regression by using 24 monthly returns in the pre-buyback period:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are t-statistics using Newey-West standard errors.

value-weighted abnormal return of the hedge portfolio (long on quintile 5 and short on quintile 1) for sentiment-to-sentiment is 0.51% per month (t-value = 1.74), indicating that a few firms with extremely large size skew the value-weighted portfolio return, resulting in unrepresentative results.

4.2. Incorporating sentiment index into the Carhart four-factor model

The previous findings show that sensitivity to sentiment is positively related to the post-buyback stock performance. If investor sentiment influences the repurchase performance, then it is reasonable to expect a reduction in post-buyback return when sentiment is controlled for in computing the abnormal return. Following this logic, I incorporate the Baker and Wurgler (2006) orthogonal sentiment index into the Carhart (1997) four-factor model and test whether abnormal results are reduced and/or become insignificant using this approach.

Table 7 presents the average monthly abnormal returns of the Carhart (1997) four-factor model after incorporating the orthogonalized sentiment index. This approach is as follows:

$$R_{pt} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + d\, sentiment^{\perp}_{t-1} + s\, SMB_t + h\, HML_t + w\, WML_t + e_t. \quad (3)$$

The definitions of R_p, r_f, r_f, r_m, SMB, HML, WML are the same as in Eq. (2). I find that abnormal returns are not significant for all repurchase firms. Abnormal returns range between 0.06% and 0.15%. In all sensitivity to sentiment groups, abnormal returns are greatly reduced and are not significant. Thus, the orthogonalized sentiment index helps to explain the post-buyback abnormal returns of repurchase firms.

In unreported results, I also examine the Fama and French three-factor model and Ibbotson (1975) RATS adding the Baker and Wurgler's sentiment index. From these two robust tests, I find that abnormal returns by adding sentiment index are also insignificant for all repurchase firms. When I divide repurchase firms into sensitivity to sentiment groups, all groups show that abnormal returns become lower after incorporating the sentiment index.

5. Other explanations and discussions

5.1. Possible contamination effects in the long-run stock performance

This paper examines long-run stock performance after repurchase announcements. The method of analyzing long-run stock performance follows the line of research beginning with Ritter (1991) for IPOs and Ikenberry et al. (1995) for repurchases. However, it is also likely that other events take place in the two-year period and contaminate the post-buyback stock performance estimation. To alleviate the contamination concern, I collect several important corporate events, including dividend initiations, dividend omissions, IPOs, mergers and acquisitions, SEOs, and abnormal capital expenditures, and then exclude those repurchases that will experience those events in two years.[27]

Panel A of Table 8 shows number of events that I collected from whole U.S. listed firms during my sample period.[28] Panel B presents annualized buy-and-hold returns for the two years after the repurchase date. By excluding other corporate events, 22% of the repurchase sample is lost. Consistent with my main results, repurchase firms with high sensitivity to sentiment earn positive abnormal return, whereas there is no abnormal return for firms with low sensitivity to sentiment. The return spread is significant at the 10% confidence level. Therefore, the findings of this paper are not driven by the contamination effect.

In addition, I consider whether the finding of this paper results from the momentum effect of the earnings announcement. In unreported results for quarterly BHAR of repurchase firms within one year after repurchase announcement, I find significantly positive return spreads between the high and low sensitivity to sentiment subgroups beginning with the third quarter. This result may be driven by the underreaction and momentum effects of the earnings announcement. Underreaction indicates that investors are slow in reflecting the effect of sensitivity to sentiment. The momentum effect implies that the gradual appreciation of BHAR over the course of 12 months may simply be the result of repurchase firm forecasting and announcing better earnings, followed by slow share price increases in reaction to this announcement. If the momentum effect of the earnings announcement could explain this finding, the momentum factor should have a stronger influence (including the significance and coefficient) on quintile 5 than quintile 1. However, the Carhart 4-factor model in Table 6 does not confirm this conjecture. Thus, the momentum effect of earnings announcement could not explain the findings in this paper.

5.2. The robust checks for the possible measures of the sensitivity to sentiment

The sensitivity-to-sentiment (i.e. sentiment beta) estimated by the simple model (Eq. (1)) may have omitted variable concern.[29] To eliminate this concern, I make two robust checks. First, I perform robustness checks for BHRs and BHARs by estimating several different measures of sensitivity to sentiment and show these results at Appendix Table A1. In this table, the sensitivities to sentiment are estimated by the non-orthogonal sentiment index, incorporating the orthogonalized sentiment index into the various market factor models (such as Fama and French (1993) three-factor model, Hou et al. (2015) new three-factor model and Fama and French (2015) five-factor model), and incorporating the orthogonalized sentiment together with liquidity factor or R&D factor into Fama and French (2015) five-factor model.[30] Appendix Table A1 shows that all abnormal returns in Quintile 1 (Quintile 5) are statistically insignificant (significant). All results of post-buyback BHRs and BHARs from these different measures of sensitivity to sentiment are quantitatively similar.[31]

Second, I also rerun the main empirical analyses using sensitivity to sentiment upon the more complete models. Specifically, I estimate the sensitivity to sentiment based on Fama–French (2015) five-factor model plus orthogonalized sentiment index

[27] I do not exclude repurchases that will experience earnings surprises after repurchases in this paper because quarterly earnings surprises are regarded as evidence in support of the investor underreaction. Chan et al. (2004) find that successive positive earnings surprises after repurchases imply inefficient markets where investors underestimate the earnings-per-share at the time repurchase announcements. Thus, I do not view earnings announcements as possible source of contamination effect on my study.

[28] Kothari and Warner (2006) conduct a census in five leading journals and report that more than 500 empirical research papers show that stock prices react sensibly to news stories. However, I do not collect all of them, which may be a research limitation of this paper.

[29] Baker and Wurgler (2006) also use Eq. (1) to measure the sensitivity to sentiment. The simple equation may have omitted variable concerns, however, the redundant variables in the regression also may result in statistical inefficiency. In addition, both situations also encounter the possible bad model problem, which may suggest an incorrect asset pricing model in estimating alpha. However, there is no best solution in the literature.

[30] See Chan et al. (2001), Pástor and Stambaugh (2003), Fama and French (2015), Hou et al. (2015) and Lin and Wang (2016) for the rationale of these pricing factors. I thank Kenneth French for making risk factors publicly available at his website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/).

[31] I also estimate the sentiment betas by non-orthogonalized sentiment index together with these various factor models and by orthogonalized (and non-orthogonalized) sentiment index with Carhart (1997) four-factor model. The unreported results of BHRs and BHARS show quantitatively similar results.

Table 7
Abnormal stock return by Carhart (1997) four-factor model with sentiment index.

Sensitivity-to-sentiment rank	Equal-weighted						Log-value-weighted						Value-weighted					
	α	β	d	s	h	w	α	β	d	s	h	w	α	β	d	s	h	w
All	0.1484	0.7196	0.3245	0.4538	−0.0664	0.6170	0.1460	0.7458	0.3046	0.4543	−0.0610	0.6364	0.0582	0.8160	−0.1443	0.2268	−0.0041	0.6202
	(1.27)	(27.46)	(9.49)	(13.88)	(−5.37)	(3.68)	(1.30)	(29.53)	(8.70)	(13.37)	(−4.64)	(3.97)	(0.64)	(33.19)	(−5.23)	(4.90)	(−0.27)	(4.67)
Quintile 1	−0.0489	0.7321	0.3595	0.3257	−0.1317	0.6500	−0.1147	0.7645	0.3350	0.3145	−0.1344	0.7359	0.0968	0.9597	0.0241	0.1284	−0.1252	0.6094
	(−0.41)	(31.93)	(8.70)	(8.04)	(−7.71)	(3.03)	(−0.90)	(33.49)	(7.67)	(7.10)	(−6.92)	(3.31)	(0.55)	(20.16)	(0.37)	(1.48)	(−4.35)	(1.66)
Quintile 2	0.0975	0.7310	0.3128	0.5209	−0.0757	0.6797	−0.0097	0.7559	0.2962	e0.5358	−0.0750	0.7260	−0.0232	0.8186	−0.2267	0.2448	−0.0218	0.7793
	(0.68)	(26.54)	(8.22)	(14.62)	(−5.26)	(3.55)	(−0.07)	(28.99)	(7.80)	(14.76)	(−5.05)	(3.81)	(−0.15)	(22.53)	(−5.24)	(4.41)	(−1.25)	(3.87)
Quintile 3	0.0975	0.7113	0.2945	0.5326	−0.0535	0.6412	0.0800	0.7378	0.2626	0.5380	−0.0464	0.6699	−0.1866	0.8542	−0.1656	0.3237	0.0351	0.7586
	(0.68)	(21.23)	(8.19)	(12.22)	(−3.88)	(3.52)	(0.50)	(21.36)	(7.01)	(11.84)	(−3.34)	(3.55)	(−1.10)	(18.94)	(−2.90)	(4.85)	(1.68)	(2.97)
Quintile 4	0.2160	0.7014	0.2792	0.4933	−0.0409	0.6158	0.1638	0.7192	0.2560	0.5123	−0.0420	0.6438	0.2442	0.7546	−0.1387	0.3917	0.0263	0.2644
	(1.54)	(21.00)	(6.86)	(10.92)	(−3.37)	(2.86)	(1.10)	(20.48)	(6.28)	(11.09)	(−3.44)	(2.94)	(1.31)	(14.04)	(−3.30)	(5.34)	(0.95)	(1.07)
Quintile 5	0.1747	0.7245	0.4115	0.4065	−0.0361	0.6552	0.1387	0.7446	0.4061	0.4208	−0.0317	0.6649	0.2171	0.7841	−0.0185	0.0844	0.0121	0.7520
	(1.12)	(16.10)	(9.19)	(8.88)	(−2.27)	(3.46)	(0.84)	(16.12)	(8.57)	(8.77)	(−1.91)	(3.58)	(1.09)	(16.38)	(−0.30)	(0.96)	(0.49)	(3.36)

This table presents the average monthly abnormal return for the two years after the repurchase announcement date. The Carhart (1997) four-factor model is specified as follows:
$R_{pt} - r_{ft} = \alpha_j + \beta(r_{mt} - r_{ft}) + d\ sentiment_{t\text{-}1}^{\perp} + sSMB_t + hHML_t + wWML_t + e_t$.
R_{pt} is the repurchase firm portfolio return and r_{ft} is the one-month T-bill rate in a given calendar month t from 1992 to 2008. r_m is the CRSP value-weighted index return, *SMB* is the small-firm portfolio return minus big-firm portfolio return, *HML* is the high book-to-market portfolio return minus low book-to-market portfolio return, and *WML* is the winner portfolio return minus loser portfolio return where winner and loser are identified by prior-year returns. For each month from 1992 to 2008, I form a calendar-time portfolio by including sample firms that have announced repurchase programs in any of the past 24 months. The portfolio returns are computed by equal-weighted, log-value-weighted, or value-weighted portfolio return. *Sensitivity to sentiment* is the coefficient (b_i) of following regression using 24 pre-buyback-period stock returns:

$$r_{it} - r_{ft} = a_i + b_i sentiment_{t-1}^{\perp} + u_{it},$$

where r_{it} is the stock return of the repurchase firm i and r_{ft} is the one-month T-bill rate at month t. $sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are t-statistics using Newey-West standard errors.

Table 8
Buy-and-hold abnormal returns excluding other corporate events.

Panel A: number of corporate events that are excluded

Event	*N*
Dividend initiation	1592
Dividend omission	2106
Initial public offerings	2165
Mergers and acquisitions	4204
Seasoned equity offerings	7014
Abnormal capital expenditures	1858

Panel B: buy-and-hold returns excluding corporate events in two years post to repurchase dates

Sensitivity-to-sentiment rank	*N*	Buy-and-hold return		Abnormal return
		Sample	Match	
All	5021	0.1603	0.1503	0.0100
		(32.83)	(36.72)	(1.76)
Quintile 1	1005	0.1442	0.1384	0.0058
		(12.29)	(14.47)	(0.45)
Quintile 2	1036	0.1240	0.1475	−0.0235
		(13.84)	(16.28)	(−2.01)
Quintile 3	982	0.1556	0.1484	0.0073
		(14.25)	(16.10)	(0.57)
Quintile 4	1006	0.1807	0.1565	0.0242
		(18.73)	(17.92)	(2.04)
Quintile 5	992	0.1985	0.1607	0.0378
		(15.40)	(17.55)	(2.63)
Quintile 1 -Quintile 5		−0.0543	−0.0223	−0.0320
		(−3.11)	(−1.68)	(−1.66)

This table presents the corporate events that are excluded from the repurchase sample (Panel A), and mean of annualized buy-and-hold returns for the two years after the repurchase date sorted by sensitivity to sentiment quintiles (Panel B). I collect six corporate events during 1990–2010. Dividend initiation includes first quarterly cash dividend of a firm. Dividend omission includes the cancelation of quarterly cash dividend payment. Dividend initiation and omission cases are collected from CRSP distribution file. Initial public offerings, mergers and acquisitions and seasoned equity offerings are collected from SDC database. Abnormal capital expenditures include the firm-year that has top-10% abnormal capital expenditures (defined by Titman et al. (2004)) relative to all Compustat/CRSP covered firms. We compute mean of annualized buy-and-hold abnormal returns using a reduced repurchase sample that excludes the repurchase firms that have participated corporate events listed in Panel A in two years post to the repurchase date. The sensitivity to sentiment is the coefficient obtained by regressing pre-buyback-period 24 monthly returns on the sentiment index of Baker and Wurgler (2006). *Buy-and-hold return* is the average of buy-and-hold returns over two years in the post-buyback period where I define a trading year as 252 days. *Sample* and *match* represent the annualized buy-and-hold return of the repurchase firm and the size/book-to-market matching firms, respectively. *Abnormal return* is the return difference between the sample firm and matching firms. I winsorize stock returns at top–bottom 1% in distribution. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are *t*-statistics.

since this five-factor model is not only the latest but also the popular factor model in recent years. The Fama–French (2015) five-factor model also subsumes the Fama–French (1993) three-factor model. The main results of using this new sensitivity to sentiment are shown in Appendix Table A2. To save space, I abstract main results from the complete tables for each panel. Panel A shows repurchase firms in quintile 5 have significantly higher BHARs than firms in quintile 1. This finding remains consistent with the result of Table 2. Panels B and C respectively show the results of post-buyback BHAR regression and Heckman two-stage regression. The coefficients of sensitivity to sentiment in these two panels are also positive significantly and thus also indicate that firms with higher sensitivity to sentiment, which are more likely to be undervalued firms, experience higher post-buyback BHARs. Panel D shows the result of monthly abnormal returns of the Carhart (1997) four-factor model. The finding of panel D remains unchanged as Table 6, also indicating significant abnormal return on the equal-weighted and log-value-weighted portfolio and insignificant abnormal return of the value-weighted portfolio. Panel E shows the abnormal returns in all sensitivity to sentiment quintiles are greatly reduced and are not significant after incorporating the orthogonalized sentiment index. This outcome also demonstrates that the orthogonalized sentiment index helps to explain the post-buyback abnormal returns of repurchase firms. Panel F shows the similar result of BHAR by this new sensitivity to sentiment excluding other corporate events in two years post to repurchase dates. All of these robust checks using this new sensitivity to sentiment based on the Fama–French (2015) five-factor model also obtain the consistent results. Therefore, the robustness checks in Appendix Table A1 and A2 are able to prevent the problems from less appropriate measure of sensitivity to sentiment.

5.3. Does the positive long-term return of repurchases come from prior or post overreaction?

The post-buyback outperformance for firms with high sensitivity to sentiment may result from two possibilities of investor overreaction. The first possibility is that investors may overreact to the bad information more strongly for firms with high sensitivity to sentiment and thereby undervalue these firms more 'before' the repurchase announcement.[32] For example, Peyer and Vermaelen (2009) propose that undervaluation of repurchase firms results from the market overreacting to bad information of these firms prior to the repurchase date. Specifically, they find that past lower performance (i.e. the significantly decline of stock price during previous 6 months) help to explain the higher post buyback abnormal return. However, in this study, Table 1 shows that quintile 5 does not have the lowest prior buyback BHAR while Table 2 shows that quintile 5 has the highest post buyback BHAR. In addition, after controlling for the prior abnormal return which Peyer and Vermaelen (2009) use to capture the overreaction bad news, these results still hold in Table 3. Thus, my finding is not driven by this overreaction to bad information 'before' the repurchase announcement.

Another explanation for stock outperformance of repurchase firms with high sensitivity to sentiment is that investors may overreact to the good news of a repurchase and may push the stock price too high because previous studies suggest the repurchase announcement is a good signal. This investor overreaction happens "at or after" repurchase date and may also cause a significantly positive long-run abnormal return. Studies of the stock market overreaction (e.g. De Bondt and Thaler, 1985; Jegadeesh and Titman, 1993) predict that (1) the movements in stock prices will be followed by subsequent price movements in the opposite direction, and (2) when stocks have more extreme movement, the subsequent price reversals will be more pronounced. Accordingly, if this post overreaction for good news of repurchases holds, the long-term return will exhibit a reversal. Specifically, for repurchase firms with high sensitivity to sentiment, these firms may be overvalued within two years and their stock performance reverses to fair value after the third or fourth year.[33] To explore this conjecture, I follow Ikenberry et al. (1995) and Chan et al. (2004) and examine long-run abnormal returns up to the fourth year. Table 9 shows annualized BHARs of third and fourth years after repurchases. Inconsistent with the post overreaction, the third and fourth-year abnormal returns of repurchase firms with high sensitivity to sentiment

[32] Mian and Sankaraguruswamy (2012) find that the effect of investor sentiment on stock price is significantly stronger for bad news than for good news, especially during bearish times.

[33] Namely, the "annualized" buy-and-hold abnormal return (BHAR) at third and fourth years should be negative significantly to offset the significantly positive annualized BHAR at the first two years. The reversal effect also means that the "cumulative" BHAR at the third and fourth years will be statistically zero.

Table 9
Buy-and-hold stock returns of the third and fourth years after repurchase date.

Sentiment-to-sentiment rank	Third-year period			Fourth-year period		
	Buy-and-hold return		Abnormal return	Buy-and-hold return		Abnormal return
	Sample	Match		Sample	Match	
All	0.1062	0.0957	0.0105	0.0830	0.0788	0.0042
	(16.44)	(18.60)	(1.51)	(10.06)	(13.94)	(0.49)
Quintile 1	0.1733	0.1412	0.0322	0.0478	0.0666	−0.0189
	(9.09)	(10.11)	(1.64)	(2.79)	(5.29)	(−1.04)
Quintile 2	0.0945	0.1117	−0.0172	0.0895	0.0844	0.0051
	(7.23)	(9.39)	(−1.14)	(5.92)	(7.11)	(0.30)
Quintile 3	0.1203	0.1031	0.0172	0.1002	0.0730	0.0271
	(8.84)	(9.29)	(1.15)	(6.46)	(6.33)	(1.60)
Quintile 4	0.1043	0.0825	0.0218	0.0688	0.0815	−0.0127
	(8.43)	(8.30)	(1.55)	(5.02)	(6.49)	(−0.81)
Quintile 5	0.0383	0.0393	−0.0010	0.1085	0.0880	0.0205
	(2.96)	(3.95)	(−0.07)	(3.87)	(6.04)	(0.77)
Quintile 1	0.1351	0.1019	0.0332	−0.0608	−0.0214	−0.0394
-Quintile 5	(5.86)	(5.94)	(1.39)	(−1.85)	(−1.11)	(−0.05)

This table presents the mean of buy-and-hold returns of the third and fourth years after the repurchase date, sorted by sensitivity to sentiment quintiles. *Buy-and-hold return* is the average of buy-and-hold returns and is calculated as 252-day compounding daily return for each event year. The sensitivity to sentiment is the coefficient obtained by regressing pre-buyback-period 24 monthly returns on the sentiment index of Baker and Wurgler (2006). *Sample* and *match* represent the annualized buy-and-hold return of the repurchase firm and the size/book-to-market matching firms, respectively. *Abnormal return* is the return difference between the sample firm and matching firms. I winsorize stock returns at top–bottom 1% in distribution. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are *t*-statistics.

are non-negative and not significantly different from zero, indicating that the post overreaction explanation is less plausible.[34]

Thus, what does sensitivity to sentiment capture in this paper? This paper proposes that the long-run post buyback abnormal return may result from the cross-sectional patterns of sentiment-driven mispricing.[35] Baker and Wurgler (2006, 2007) argue that the effect of sentiment on the cross-sectional stock prices is driven from two channels: the sentiment-based demand shocks and difficulty of arbitrage. In the first channel, they view the sentiment as the demand for the speculative securities and suggest that some stocks are more speculative because the values of these stocks are more difficult to determine or more subjective. In the second channel, investor sentiment is regards as optimistic or pessimistic about stocks in general. These indiscriminate waves of sentiment may have greater effect on some stocks when the arbitrage of these stocks tends to be particularly risky and costly. In addition, Baker and Wurgler (2007) also show that the more speculative and more difficult-to-arbitrage stocks are more sensitive to sentiment (i.e. higher sentiment betas). Thus, this paper concludes that sentiment-driven mispricing (i.e. the mispricing from high sentiment betas) may result from difficulty to value and/or hard to arbitrage, which cause Shleifer and Vishny (1997) style mispricing.[36] Specifically, the trading of irrational investors may result in mispricing when the market has friction which rational investors cannot arbitrage well. To further examine my argument that firms with high sensitivity to sentiment are more likely to be hard-to-arbitrage and/or speculative firms, I follow Lam and Wei (2011) and compute several measures of limits to arbitrage.[37] Lam and Wei (2011) shows that firms with high idiosyncratic volatility, or low analyst coverage, or small firms, or young firms are more likely to be hard to arbitrage or difficult to value. The unreported results show that the sensitivity to sentiment is significantly positively correlated with idiosyncratic volatility and is significantly negatively correlated with analyst coverage, firm age and size. Thus, the results of correlation coefficients in part confirm my conjecture that high beta firms are more difficult to arbitrage.

Finally, the assessment that the high sensitivity-to-sentiment firms are more likely to be hard-to-arbitrage and/or difficult-to-value firms does not depend solely on one arbitrage mechanism such as short selling constraints. Lam and Wei (2011) present four aspects of the limits to arbitrage and suggest that firms with more information uncertainty, higher arbitrage risk, higher transaction costs and less shareholder sophistication are more difficult to arbitrage firms. Accordingly, the short selling constraint is the one factor of transaction cost that affects the limits to arbitrage. The short selling constraints may result in overvaluation. However, other possible factors for the limits of arbitrage may result in undervaluation. For example, firms with low analyst coverage (those firms tend to be high limits to arbitrage) are associated with undervaluation and higher future returns (e.g. Doukas et al., 2008; Louis and White, 2007). Thus, the argument that the difficulty-to-arbitrage stocks can be undervalued is not restricted to just one arbitrage mechanism.[38]

5.4. Is the effect of sensitivity to sentiment unique for the repurchase sample?

This paper suggests a positive relationship between sensitivity to investor sentiment and post-buyback stock performance and accordingly argues that investors underreact to the firms' value and thereby cause post-buyback stock outperformance. However, it is plausible that other firms (e.g., non-repurchase stocks) earn higher returns when they are more sensitive to investor sentiment. If this conjecture is true, then my finding could be driven by a universal effect.

[34] In unreported results, I compute the abnormal returns for the fifth and sixth year and they are also not significant.

[35] Many studies of repurchases document that the prior undervaluation helps to explain the long-run post buyback abnormal return (e.g., Barth and Kasznik, 1999; Chan et al., 2004; Ikenberry et al., 1995). The prior-repurchase undervaluation is also called mispricing.

[36] Baker and Wurgler (2006, 2007) and I do not try to distinguish the effects from these two channels because Baker and Wurgler (2006) argue that these two channels yield the similar predictions, since the same stocks that are difficult to arbitrage also tend to be the most difficult to value.

[37] Lam and Wei (2011) use ten measures to estimate the limits to arbitrage. For example, they use idiosyncratic stock return volatility to measure the arbitrage risk, and use some analyst information to measure information uncertainty.

[38] Baker and Wurgler (2007) also support this argument.

Table 10
Abnormal stock return by the Carhart (1997) four-factor model- Whole Listed Firms.

Sensitivity-to-sentiment rank	Equal-weighted					Log-value-weighted					Value-weighted				
	α	β	s	h	w	α	β	s	h	w	α	β	s	h	w
All	0.2114	0.6251	0.4439	0.1997	−0.1521	0.2347	0.9379	0.6728	0.3094	−0.1774	0.0748	0.9660	−0.0817	0.0180	−0.0206
	(1.50)	(7.90)	(6.59)	(4.78)	(−2.99)	(1.41)	(43.33)	(18.23)	(13.27)	(−6.11)	(2.06)	(75.72)	(−7.87)	(1.00)	(−3.28)
Quintile 1	0.1123	0.6388	0.4366	0.1776	−0.1290	0.2964	0.9225	0.6752	0.2632	−0.1865	0.0458	0.9830	−0.0403	−0.0996	−0.0270
	(0.76)	(9.96)	(5.86)	(4.13)	(−2.61)	(1.72)	(67.58)	(13.81)	(8.72)	(−9.26)	(0.66)	(38.23)	(−0.90)	(−1.80)	(−0.63)
Quintile 2	0.1948	0.6751	0.4816	0.2388	−0.1770	0.2475	0.9547	0.6715	0.3313	−0.1961	0.0498	0.9463	−0.0780	0.1019	−0.0394
	(1.62)	(8.64)	(7.78)	(5.77)	(−3.90)	(1.69)	(54.41)	(18.46)	(8.75)	(−9.56)	(0.79)	(43.15)	(−3.08)	(2.02)	(−2.26)
Quintile 3	0.2072	0.5926	0.4452	0.1723	−0.1230	0.2222	0.9400	0.6719	0.3074	−0.1682	0.0894	0.9539	−0.0648	0.0655	−0.0441
	(1.80)	(7.76)	(7.65)	(3.86)	(−2.58)	(1.47)	(51.27)	(21.55)	(9.50)	(−5.46)	(1.25)	(45.15)	(−1.95)	(1.81)	(−2.07)
Quintile 4	0.1425	0.6008	0.3966	0.1710	−0.1269	0.1952	0.9462	0.6956	0.3360	−0.1731	0.1281	0.9621	−0.0602	0.0383	−0.0023
	(1.05)	(7.85)	(5.64)	(4.45)	(−2.21)	(1.11)	(30.25)	(17.23)	(12.85)	(−4.51)	(2.22)	(51.35)	(−2.32)	(1.05)	(−0.20)
Quintile 5	0.1912	0.5834	0.3946	0.1645	−0.1087	0.2093	0.9262	0.6492	0.3105	−0.1620	0.0661	0.9691	−0.1531	0.0066	0.0021
	(1.21)	(8.03)	(4.75)	(3.57)	(−1.62)	(1.05)	(22.30)	(16.83)	(13.67)	(−3.82)	(0.97)	(31.53)	(−3.64)	(0.10)	(0.07)
Quintile 1	0.0840	0.0077	0.0254	−0.0273	−0.0300	0.0871	−0.0037	0.0260	−0.0473	−0.0244	−0.0203	0.0139	0.1129	−0.1062	−0.0291
-Quintile 5	(0.96)	(0.18)	(0.75)	(−1.17)	(−0.87)	(1.32)	(−0.09)	(0.70)	(−1.61)	(−0.78)	(−0.17)	(0.31)	(1.58)	(−0.94)	(−0.42)

This table presents the average monthly abnormal return for the two years after June end of each calendar year using whole U.S. listed firms. The Carhart (1997) four-factor model is specified as follows:

$$R_{pt} - r_{ft} = \alpha + \beta(r_{mt} - r_{ft}) + sSMB_t + hHML_t + wWML_t + e_t.$$

R_{pt} is the portfolio return and r_{ft} is the one-month T-bill rate in a given calendar month t from 1992 to 2008. r_m is the CRSP value-weighted index return, *SMB* is the small-firm portfolio return minus big-firm portfolio return, *HML* is the high book-to-market portfolio return minus low book-to-market portfolio return, and *WML* is the winner portfolio return minus loser portfolio return where winner and loser are identified by prior-year returns. For each month from 1992 to 2008, I form a calendar-time portfolio by including U.S. listed firms that have listed for at least 24 months in order to estimate the sensitivity to sentiment. The portfolio returns are computed by equal-weighted, log-value-weighted or value-weighted portfolio return. *Sensitivity to sentiment* is the coefficient (b_i) of following regression by using 24 monthly returns before June end of each calendar year:

$$r_{it} - r_{ft} = a_i + b_i sentiment^{\perp}_{t-1} + u_{it},$$

where r_{it} is the stock return of the firm i and r_{ft} is the one-month T-bill rate at month t. $sentiment^{\perp}$ is the orthogonalized sentiment index of Baker and Wurgler (2006). Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile. Numbers in parentheses are t-statistics using Newey-West standard errors.

Table A1
Buy-and-hold stock return sorted by sensitivity to sentiment from various specifications.

Model Specifications	Sentiment			Fama–French three factors + sentiment$^{\perp}$			New three factors + sentiment$^{\perp}$			Fama–French five factors + sentiment$^{\perp}$			Fama–French five factors + LIQ factor + sentiment$^{\perp}$			Fama–French five factors + R&D factor + sentiment$^{\perp}$		
	Buy-and-hold return		Abnormal return	Buy-and-hold return		Abnormal return	Buy-and-hold return		Abnormal return	Buy-and-hold return		Abnormal return	Buy-and-hold return		Abnormal return	Buy-and-hold return		Abnormal return
	Sample	Match		Sample	Match		Sample	Match		Sample	Match		Sample	Match		Sample	Match	
Quintile 1	0.1520	0.1400	0.0120	0.1537	0.1364	0.0174	0.1480	0.1389	0.0092	0.1554	0.1528	0.0026	0.1618	0.1503	0.0115	0.1499	0.1565	−0.0066
	(13.94)	(16.07)	(1.01)	(14.55)	(15.27)	(1.43)	(14.28)	(15.93)	(0.78)	(14.35)	(16.29)	(0.20)	(14.84)	(16.36)	(0.90)	(14.21)	(16.51)	(−0.53)
Quintile 2	0.1498	0.1502	−0.0004	0.1462	0.1430	0.0032	0.1547	0.1505	0.0042	0.1626	0.1466	0.0160	0.1666	0.1494	0.0172	0.1769	0.1513	0.0256
	(16.91)	(18.24)	(−0.04)	(16.23)	(17.16)	(0.29)	(16.97)	(18.33)	(0.38)	(17.13)	(18.47)	(1.49)	(16.80)	(18.33)	(1.51)	(16.77)	(18.91)	(2.16)
Quintile 3	0.1535	0.1480	0.0056	0.1612	0.1579	0.0032	0.1537	0.1552	−0.0015	0.1467	0.1513	−0.0046	0.1398	0.1547	−0.0149	0.1598	0.1490	0.0108
	(18.41)	(18.04)	(0.52)	(17.11)	(19.79)	(0.29)	(17.85)	(18.67)	(−0.13)	(16.91)	(19.03)	(−0.43)	(16.79)	(19.48)	(−1.44)	(18.57)	(18.92)	(1.03)
Quintile 4	0.1565	0.1515	0.0050	0.1693	0.1495	0.0198	0.1621	0.1555	0.0067	0.1719	0.1570	0.0149	0.1720	0.1511	0.0210	0.1584	0.1469	0.0116
	(16.83)	(19.04)	(0.44)	(19.06)	(18.63)	(1.83)	(17.09)	(18.81)	(0.60)	(18.13)	(18.86)	(1.28)	(18.15)	(18.07)	(1.83)	(17.28)	(18.39)	(1.03)
Quintile 5	0.2193	0.1652	0.0541	0.2002	0.1681	0.0321	0.2124	0.1548	0.0576	0.1943	0.1468	0.0475	0.1905	0.1492	0.0413	0.1856	0.1509	0.0347
	(18.05)	(19.31)	(4.03)	(16.89)	(20.12)	(2.43)	(17.55)	(18.97)	(4.33)	(17.11)	(18.44)	(3.84)	(17.02)	(18.70)	(3.38)	(16.86)	(18.36)	(2.83)
Quintile 1 -Quintile 5	−0.0673	−0.0253	−0.0421	−0.0464	−0.0317	−0.0148	−0.0644	−0.0159	−0.0485	−0.0389	0.0060	−0.0449	−0.0286	0.0012	−0.0298	−0.0357	0.0056	−0.0413
	(−4.12)	(−2.07)	(−2.34)	(−2.92)	(−2.59)	(−0.82)	(−4.04)	(−1.33)	(−2.74)	(−2.48)	(0.05)	(−2.53)	(−1.83)	(0.10)	(−1.69)	(−2.34)	(0.44)	(−2.36)

This table presents the mean of annualized buy-and-hold returns after the repurchase date sorted by sensitivity to sentiment quintiles where I estimate the sensitivity to sentiment in six ways. The model of 'Sentiment' indicates that the sensitivity to sentiment is estimated by $r_{it} - r_{ft} = a_i + b_i sentiment_{t-1} + u_{it}$. r_{it} is the stock return of the repurchase firm i, r_{ft} is the one-month T-bill rate, and *sentiment* is the (non-orthogonalized) sentiment index in Baker and Wurgler (2006). The model of 'Fama–French three factors + sentiment$^{\perp}$', indicates that the sensitivity to sentiment is estimated by $r_{it} - r_{ft} = a_i + \beta(r_{mt} - r_f) + d\ sentiment^{\perp}_{t-1} + s\ SMB_t + h\ HML_t + u_{it}$. The model of 'New three factors + sentiment$^{\perp}$', indicates that the sensitivity to sentiment is estimated by $r_{it} - r_{ft} = a_i + \beta(r_{mt} - r_f) + d\ sentiment^{\perp}_{t-1} + s\ CMA_t + h\ RMW_t + u_{it}$. The model of 'Fama–French five factors + sentiment$^{\perp}$', indicates that the sensitivity to sentiment is estimated by $r_{it} - r_{ft} = a_i + \beta(r_{mt} - r_f) + d\ sentiment^{\perp}_{t-1} + s\ SMB_t + h\ HML_t + c\ CMA_t + r\ RMW_t + u_{it}$. The model of 'Fama–French five factors + sentiment$^{\perp}$ + LIQ factor' indicates that the sensitivity to sentiment is estimated by $r_{it} - r_{ft} = a_i + \beta(r_{mt} - r_f) + d\ sentiment^{\perp}_{t-1} + s\ SMB_t + h\ HML_t + c\ CMA_t + r\ RMW_t + l\ LIQ_t + u_{it}$. The model of 'Fama–French five factors + sentiment$^{\perp}$ + R&D factor' indicates that the sensitivity to sentiment is estimated by $r_{it} - r_{ft} = a_i + \beta(r_{mt} - r_f) + d\ sentiment^{\perp}_{t-1} + s\ SMB_t + h\ HML_t + c\ CMA_t + r\ RMW_t + n\ R\&D_t + u_{it}$. $sentiment^{\perp}$ is the orthogonalized sentiment index in Baker and Wurgler (2006); *SMB* is the small-firm portfolio return minus big-firm portfolio return; *HML* is the high book-to-market portfolio return minus low book-to-market portfolio return; *RMW* is the high operating profitability return minus low operating profitability return; *CMA* is the low asset growth returns minus high asset growth returns; *LIQ* is the liquidity of Pástor and Stambaugh (2003). R&D factor is high R&D intensity return minus low R&D intensity return. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile for the various specifications. Numbers in the parentheses are *t*-statistics.

Table A2
Main empirical results using sensitivity to sentiment from the Fama–French (2015) five-factor model.

Panel A: buy-and-hold stock return

Sensitivity-to-sentiment rank	Buy-and-hold return		Abnormal return
	Sample	Match	
Quintile 1	0.1554	0.1528	0.0026
	(14.35)	(16.29)	(0.20)
Quintile 5	0.1943	0.1468	0.0475
	(17.11)	(18.44)	(3.84)
Quintile 1–Quintile 5	−0.0389	0.0060	−0.0449
	(−2.48)	(0.05)	(−2.53)

Panel B: buy-and-hold abnormal return regression

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.0219	0.0086	0.0089	0.0046	0.0044	0.0117
	(3.30)	(−1.12)	(−1.46)	(0.59)	(0.24)	(0.58)
Sensitivity to sentiment	0.1239			0.1207	0.1506	0.2060
	(3.61)			(3.55)	(2.92)	(3.19)
B/M		0.0122		0.0120	0.0026	0.0030
		(−2.00)		(1.98)	(0.28)	(0.33)
Prior abnormal return			−0.0594	−0.0585	−0.0642	−0.0645
			(−4.32)	(−4.28)	(−3.34)	(−3.36)
Other control variables	No	No	No	No	Yes	Yes

Panel C: Heckman two-stage regression analysis for buy-and-hold abnormal returns

	Model 1	Model 2	Model 3
Stage 2: buy-and-hold abnormal return regression			
Intercept	−0.0257	0.0507	0.0728
	(−0.31)	(0.57)	(0.75)
Sensitivity to sentiment	0.1533	0.1612	0.2261
	(2.85)	(2.65)	(2.73)
B/M	−0.0507	−0.0586	−0.0587
	(−2.60)	(−2.72)	(−2.73)
Prior abnormal return	0.0062	0.0041	0.0043
	(0.58)	(0.35)	(0.36)
Other control variables	No	Yes	Yes

Panel D: abnormal stock return by the Carhart (1997) four-factor model

	Equal-weighted	Log-value-weighted	Value-weighted
Quintile 1	0.0761	0.0406	−0.0102
	(0.61)	(0.30)	(−0.05)
Quintile 5	0.2842	0.2597	0.1311
	(1.92)	(1.64)	(0.57)
Quintile 1–Quintile 5	−0.2334	−0.2933	−0.2357
	(−1.99)	(−2.31)	(−0.82)

Panel E: abnormal stock return by Carhart (1997) four-factor model with sentiment index

	Equal-weighted	Log-value-weighted	Value-weighted
All	0.1484	0.1460	0.0582
	(1.27)	(1.30)	(0.64)
Quintile 1	−0.0574	−0.1307	−0.1766
	(−0.48)	(−1.05)	(−1.01)
Quintile 2	0.1758	0.1028	−0.1238
	(1.22)	(0.68)	(−0.65)
Quintile 3	0.0698	0.0540	0.1902
	(0.50)	(0.35)	(1.06)
Quintile 4	0.1740	0.0950	0.1268
	(1.30)	(0.70)	(0.69)
Quintile 5	0.1568	0.1195	0.0400
	(1.00)	(0.71)	(0.17)

Panel F: buy-and-hold abnormal returns excluding other corporate events

	Buy-and-hold return		Abnormal return
	Sample	Match	
Quintile 1	0.1603	0.1503	0.0100
	(32.83)	(36.72)	(1.76)
Quintile 5	0.1814	0.1477	0.0337
	(14.52)	(16.46)	(2.49)
Quintile 1–Quintile 5	−0.0305	0.0048	−0.0353
	(−1.75)	(0.35)	(−1.81)

This table presents the main empirical results by sensitivity to sentiment quintiles where I estimate the sensitivity to sentiment based on Fama–French five factors plus orthogonalized sentiment index, indicating that the sensitivity to sentiment is estimated by
$r_{it}-r_{ft} = a_i + \beta(r_{mt}-r_f) + d\ sentiment^{\perp}{}_{t-1} + s\ SMB_t + h\ HML_t + c\ CMA_t + r\ RMW_t + u_{it}$.
$Sentiment^{\perp}$ is the orthogonalized sentiment index in Baker and Wurgler (2006). *SMB* is the small-firm portfolio return minus big-firm portfolio return; *HML* is the high book-to-market portfolio return minus low book-to-market portfolio return; *RMW* is the high operating profitability return minus low operating profitability return; *CMA* is the low asset growth returns minus high asset growth returns. Quintiles 1–5 represent the lowest sensitivity to sentiment quintile to the highest sensitivity to sentiment quintile for the various specifications. Numbers in the parentheses are *t*-statistics. Panel A presents the BHRs and BHARs for quintiles 1 and 5. Panels B and C respectively show the result of post-buyback BHAR regression and Heckman two-stage regression. Panel D shows the result of monthly abnormal returns of the Carhart (1997) four-factor model. Panel E shows the abnormal stock return by Carhart (1997) four-factor model with sentiment index. Panel F shows the BHAR result by this new sensitivity to sentiment excluding other corporate events in two years post to repurchase dates. I abstract main results from the complete table for each panel to save space.

Therefore, I compute sensitivities to sentiment for all Compustat/CRSP covered firms, and sort abnormal returns by the sensitivity to sentiment.[39] Similar to Table 6, I calculate Carhart (1997) based abnormal returns sorted ranks of sensitivity of sentiment for all listed firms and report abnormal returns in Table 10.[40] Equal-weighted, log value-weighted, and value-weighted abnormal returns are computed. I find that there is no return difference for all the abovementioned weighting schemes. This finding is reasonable because stocks with high sensitivity to sentiment could be undervalued more (for example, the repurchase cases) or overvalued more (for example, the SEO cases), depending on the market timing condition. Even when focusing on non-repurchase firms, no effect is found since effects from overvalued stocks and undervalued non-repurchase stocks cancel each other out.[41]

6. Conclusion

This study examines investor sentiment and share repurchases. Using the Baker and Wurgler (2006) sentiment index, I find that after repurchases, firms with high sensitivity to sentiment experience positive abnormal returns whereas firms with low sensitivity to sentiment earn insignificant abnormal returns. I also find that the abnormal return related to the sensitivity to sentiment is not driven by book-to-market or prior return effects. In addition, the higher information asymmetry strengthens the sentiment-driven mispricing effect. The abnormal return estimations using the Carhart (1997) four-factor model support the contention that repurchase firms with higher sensitivity to sentiment earn higher post-buyback abnormal returns. By incorporating the sentiment index into the Carhart (1997) four-factor model, the post-buyback abnormal returns become smaller and less significant.

The result of post-buyback stock outperformance is robust even when I exclude the possible contamination effects from other corporate events. In addition, I exclude the possible prior and post investor overreaction and suggest the sentiment-driven undervaluation may result from the difficulty to value and/or limit to arbitrage. Finally, I show that the effect of sensitivity to sentiment is unique for the repurchase sample rather than all firms. All of these results show that the sensitivity to sentiment helps to explain the post-buyback stock performance and suggest that the pre-buyback undervaluation of repurchase firms in part results from the sensitivity of investor sentiment.

Appendix A

See Tables A1 and A2.

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[39] In unreported results, I find conclusion unchanged if I focus on non-repurchase firms only.

[40] I also calculate abnormal return by Fama and French (1993) three factor model for whole listed firms and still have the similar result.

[41] Stocks without repurchases could be undervalued firms as well, for example dividend paying firms and R&D increasing stocks (Miller and Rock, 1985; Szewczyk et al., 1996)

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