Shorting costs and asymmetry in mispricing

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We hypothesize that overpricing shows up more often than underpricing if short-selling is costly relative to buying so that there is arbitrage asymmetry, and document the followings. First, put-optioned stocks, which are supposed to be less costly to short, have less anomaly profits than non-put-optioned stocks. Second, in high-sentiment periods, short-legs of anomaly portfolios are more profitable with put-optioned stocks than non-put-optioned stocks, while, in low-sentiment periods, short-legs are not profitable with both subsamples of stocks. Third, returns on short-legs of anomaly portfolios are negatively related to lagged sentiment only when the degree of market-wide arbitrage asymmetry is high, where arbitrage asymmetry is measured by the difference of the market impact costs between the up market and the down market or by the market-wide average change in breadth. Finally, anomalies associated with capital investments do not seem to be caused by the presence of short-sale constraints.

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1. Introduction

Investor sentiment may cause asset prices to be deviated from their fundamental values when arbitrage is limited (Shleifer and Vishiny, 1997). Especially in the presence of short-sale constraints, overpricing induced by high investor sentiment would be difficult to be eliminated.[1] Recently, Stambaugh, Yu, and Yuan (2012a, hereafter SYY) assess this issue by exploring the wide set of asset-pricing anomalies. They document that high sentiment produces overpricing more often than low sentiment produces underpricing. In particular, they show that the short-legs of anomaly-based strategies are more profitable in months following high sentiment than in those following low sentiment, while the long-legs of the strategies have similar returns following high and low sentiment. They interpret these empirical results to indicate that the short-legs are likely to be overpriced in high-sentiment periods while the long-legs are not, and furthermore, neither the short-leg nor the long-leg is susceptible to underpricing during periods of low sentiment.

Their empirical works lead us to conjecture that the relative difficulty of selling versus buying is the source of asymmetry in mispricing. The short-legs, presumably more costly to short, would be more likely to be overpriced when investor sentiment is high but less likely to be underpriced when investor sentiment is low. In contrast, the long-legs, seemingly less costly to long, would be less susceptible to mispricing regardless of investor sentiment. As a result, only the short-legs of anomaly-based long-short strategies exhibit an asymmetric sentiment-return relation. In other words, since it is relatively difficult to short sell than to buy, the asymmetry between during high- and low-sentiment periods shows up by different size of mispricing in short-legs. Stambaugh, Yu, and Yuan (2012c) call such relative difficulty in exploiting overpricing versus underpricing "arbitrage asymmetry."

[1] The influence of short-sale restriction on asset prices dates back to Miller (1977), who argues that when there are short-sales constraints, stock's price will reflect optimistic valuation. Other studies related to this concept include Figlewisk (1981), Chen, Hong, and Stein (2002), Diether, Malloy, and Scherbina (2002), Duffie, Garleanu, and Pedersen (2002), Jones and Lamont (2002), D'Avolio (2002), Scheinkman and Xiong (2003), Lamont and Stein (2004), Nagel (2005), Boehme, Danielsen, and Sorescu (2006), and Stambaugh, Yu, and Yuan (2012a, 2012c). Studies on the relation between investor sentiment and asset returns include Delong et al. (1990), Shleifer and Summers (1990), Lee, Shleifer, and Thaler (1990), Baker and Wurgler (2006, 2007), Kumar and Lee (2006), Chung, Hung, and Yeh (2012), Stambaugh, Yu, and Yuan (2012a, 2012b, 2012c), and Lee (2012).

This article further investigates whether or not arbitrage asymmetry results in asymmetry in sentiment-driven mispricing. That is, we focus on arbitrage asymmetry as the primary source of asymmetry in mispricing. If the relative difficulty of shorting versus buying leads to asymmetric effects of sentiment on mispricing, it should disappear in the absence of arbitrage asymmetry. Consistently, with higher asymmetry in impediments to arbitrage, the sentiment effect should exhibit greater asymmetry. In this sense, we hypothesize that asymmetry in mispricing is increasing in arbitrage asymmetry, and then investigate this hypothesis empirically.

In accordance with SYY, we explore the relation between the returns on the long-short strategies of anomaly-based trading and sentiment. Our hypothesis, first, predicts that the profitability of the long-short strategies based on anomalies exhibits greater asymmetry in mispricing within the subsample of stocks with a higher degree of arbitrage asymmetry. The cross-sectional difference in arbitrage asymmetry across stocks could be related to their magnitude of asymmetry in mispricing. Similarly, it predicts that the profitability of the long-short strategies is closely related to investor sentiment when market-wide asymmetry in arbitrage impediments is greater. The time-variation in aggregate arbitrage asymmetry can also influence sentiment-return relations.

Lastly, we re-examine whether mispricing is appropriate as the explanation of the broad set of anomalies. The finding that anomaly-based strategies derive their profitability from taking short positions in the short-legs during high-sentiment periods supports a scenario in which mispricing is the source of the anomaly. In this sense, the relation between arbitrage asymmetry and the profitability of the anomaly-based strategy can be indicative of the extent to which the anomaly reflects overpricing. Hence, we explore the array of well-documented anomalies and verify which one is associated with overpricing induced by arbitrage asymmetry.

Now, what is left is how to measure the level of arbitrage asymmetry. On the basis of prior studies, in the cross-section, we regard stocks with (without) a tradable put option as those with the low (high) level of arbitrage asymmetry. Prior literature including Figlewski and Webb (1993) documents that buying put options can be an alternative way to make a negative bet on an underlying stock, which

implies that a put option can be used for arbitrageurs to exploit overpricing of the underlying stock.[2] According to this implication, we presume that stocks with actively traded put options have lower level of arbitrage asymmetry. A stock having at least one put option with positive trading volume is considered as one with low asymmetry in impediments to arbitrage.[3]

We adopt two measures to proxy the degree of market-wide arbitrage asymmetry – the difference in aggregate illiquidity between up and down markets, and the average change in breath of institutional ownership. Brennan, Hur, and Subrahmanyam (2013), inspired by the presence of asymmetry in price impacts between sales and purchases, propose the half-Amihud measures.[4] They conjecture that illiquidity in up markets and down markets can be different, and decompose the Amihud (2002) illiquidity measure into two elements that correspond to up and down days. In particular, they define the half-Amihud measure for up (down) days as the Amihud measure that is calculated using only data from positive (negative) return days. We use the difference between the two half-Amihud measures – the half-Amihud measure for down days minus the half-Amihud measure for up days – as our first proxy for the degree of market-wide arbitrage asymmetry. Consistent with Brennan, Hur, and Subrahmanyam (2013), the half-Amihud measure for down days is, as a whole, greater than that for up days throughout our sample period in unreported results.

The second proxy is the average change in breadth of institutional ownership. Chen, Hong, and Stein (2002) suggest that breadth of ownership proxies how tightly short-sale constraints bind, where breadth roughly refers to the number of investors with long position in a particular stock. According to them, low breadth signals that short-sale constraint is binding tightly.[5] On the basis of such argument,

[2] Other studies addressing an option as a substitute for short selling include Safieddine and Wilhelm (1996), Sorescu (2000), Danielson and Sorescu (2001), Ofek, Richardson, and Whitelaw (2004), Mayhew and Mihov (2005), and Phillips (2011).

[3] Senchack and Stark (1993), and Henry and Koski (2010) adopt the similar approach. For example, Senchack and Stark (1993) presume that the availability of traded options can reduce the cost of establishing what is effectively a short position, and then divide the total sample into the optioned and the non-optioned subsamples for their empirical study.

[4] Brennan et al. (2012) find that the average difference between sell- and buy-order illiquidity measures is generally positive for a large cross-section of stocks over 26 years, and also find that it co-moves with the TED spread which is a measure of funding illiquidity.

[5] Chen, Hong, and Stein (2002) find that stocks whose change in breadth in the prior quarter is in the lowest decile underperform those in the top decile in the twelve months after formation, and argue that this finding supports Miller's idea.

we use the average change in breadth of institutional ownership as our second proxy for market-wide arbitrage asymmetry, expecting that change in breath is negatively correlated with market-wide arbitrage asymmetry.

Our empirical findings can be summarized as follows. First, we find that returns on the long-short anomaly strategies are more asymmetrically related to sentiment among stocks with tradable put options than among stocks without tradable put options. Within the subsample of non-put-optioned stocks, anomaly-based strategies are, as a whole, more significantly profitable following high sentiment, while they are less profitable following low sentiment. On the other hand, within the subsample of put-optioned stocks, we observe little or no significant differences in profits across investor sentiment. These results strongly support our hypothesis that arbitrage asymmetry plays a role in the asymmetric effect of sentiment on mispricing. With put options, the difficulty of shorting is rather reduced, and hence, stocks are less susceptible to mispricing even in high-sentiment periods; as a result, they exhibit less significant asymmetry in mispricing. Our empirical evidence confirms such inference.

Second, we find that, in high-sentiment periods, the short-legs of anomaly-based strategies are more profitable among non-put-optioned stocks than among put-optioned stocks, while there is little difference in profits between the two subsamples in low-sentiment periods. This finding is also supportive for a role of shorting costs in stock overpricing. Since stocks without tradable put options are more costly to short compared to those with tradable put options, they might be more overpriced, and as a result, exhibit lower returns following high sentiment.

Third, we document that returns on the short-leg are negatively related to lagged sentiment only when market-wide arbitrage asymmetry is high. Even returns on the short-leg in the non-put-optioned subsample exhibit no or little relation with investor sentiment in low-arbitrage-asymmetry periods. This evidence confirms the relation between arbitrage costs and sentiment-driven mispricing. High shorting costs, in the time-series as well as in the cross-section, allows market-wide sentiment to affect asset prices, especially more when there is a tendency for overpricing. Reverse reasoning can

also be applied. If market-wide asymmetry in arbitrage impediments is not severe, sentiment cannot influence stock prices at all even when investor sentiment is high.

Lastly, we find that anomalies related to financial distress, momentum, and profitability is associated with mispricing induced by arbitrage asymmetry to some extent, while those related to capital investment are not. Recent empirical studies have attempted to explain the array of seemingly unrelated anomalies in a unified framework. They investigate commonalities across anomalies and try to reveal what drives the whole or part of them.[6] For example, SYY link the profitability of anomaly-based strategies to mispricing, suggesting the possibility that sentiment-induced overpricing generates their anomalous profits. However, their study does not provide any reason why greater mispricing is accompanied with more extreme values of a particular characteristic used to produce an anomaly. Our paper contributes in this respect. We examine the relation between mispricing and anomalies by adopting a concept of arbitrage asymmetry and a role of put options together. If mispricing, especially overpricing, is the source of the anomaly, we can earn greater profits by constructing the portfolio strategy with stocks more likely to be overpriced. Our empirical works in this manner suggest that anomalies herein considered seem to be associated with sentiment-inducing overpricing, except for those related to capital investment.

The first contribution of this article is that we extend and confirm the empirical evidence provided by SYY by showing that arbitrage asymmetry induced by short-sale constraints plays a significant role in the asymmetric role of sentiment. Put-optioned stocks, which are less likely to have difficulties exploiting negative information, have little difference in profits across sentiment, while non-put-optioned stocks, which suffer more from short-sale constraints, show more difference in profits across sentiment. Furthermore, returns on short-legs are related to the sentiment only when the market-wide arbitrage asymmetry is high. These empirical findings strengthen SYY significantly. The second

[6] Studies on commonalities or relations across asset-pricing anomalies include Avramov et al. (2009, 2013), Li, Livdan, and Zhang (2009), Chen, Novy-Marx, and Zhang (2010), Li and Zhang (2010), Wu, Zhang, and Zhang (2010), Li and Sullivan (2011), Stambaugh et al. (2012a, 2012c), Novy-Marx (2013), and Israel and Moskowitz (2013). Novy-Marx (2013), for example, addresses that a large number of anomalies are just different expressions of a couple of basic anomalies, mixed in various proportions and dressed up in different guises.

contribution is to provide an additional evidence that the existence of a put option market can enhance the market efficiency by reducing the short-sale costs. The literature shows that options can broaden the investment set of investors considerably.[7] If the underlying asset market restricts investors' choice set significantly as in the case of short-sales constraints, the presence of options can improve the market efficiency by creating a new opportunity to detour the restrictions. Our example shows one important example. The last contribution of our article is that we provide evidence on which anomalies may be accounted for by the short-sale constraints.

The remainder of this paper is organized as follows. Section 2 describes our data and portfolios. Section 3 discusses our main empirical results. Section 4 concludes.

2. Data and measures

We explore thirteen asset-pricing anomalies; eleven anomalies are the same as those studied by SYY, and the other two are those related to dispersion in investors' opinion and credit rating, respectively. Diether, Malloy, Scherbina (2002) document that stocks with higher dispersion in analysts' opinion earn lower future returns than those with lower dispersion. Their finding is apparently consistent with Miller (1977)'s model, which predicts that stocks can reflect more optimistic valuations when investors have different valuation and short sales are constrained. According to Miller's intuition, the analyst-disagreement anomaly should disappear in the absence of the short-sale constraint. As such, we take this anomaly into our consideration, expecting it to be closely associated with arbitrage asymmetry.

The anomaly related to credit rating is first documented by Avramov et al. (2009). They find that low-

[7] Ross (1976) develops this idea first. Bakshi, Cao, and Chen (2000) and many other papers provide empirical evidence that options broaden the investment opportunity set beyond the one by the underlying asset market.

rated firms earn higher returns than higher-rated firms, which is anomalous in that investors seem to pay a premium for bearing credit risk. A recent interesting work on this anomaly is carried out by Avramov et al. (2013). They find that the profitability of various anomalies is concentrated in worst-rated firms. Specifically, they show 7 out of 9 anomaly-based strategies are significantly profitable only within the subsample of worst-rated stocks, and then suggest that mispricing among low-rated stocks is the source of the anomalies.

Our analysis is based on various portfolio sorts. We construct the long-short strategies for each anomaly according to SYY. For the analyst-disagreement anomaly and the credit-rating anomaly, not used in SYY, we follow Diether, Malloy, and Scherbina (2002) and Avramov et al. (2009), respectively. When implementing strategies, stocks are first sorted into decile portfolios based on the anomaly's sorting variable. We then obtain equal-weighted decile portfolio returns across all stocks as well as within the subsets divided by the availability of tradable put options. As mentioned earlier, we measure the degree of arbitrage asymmetry for each stock on the basis of the presence of tradable put options. In particular, at the end of each month, we divide stocks in our sample into two groups so that stocks having no put options traded during the previous month belong to the non-put-optioned subsample and the others belong to the put-optioned subsample. Stocks in the non-put-optioned (put-optioned) subsample are regarded as those with higher (lower) levels of arbitrage asymmetry.

Meanwhile, the level of market-wide arbitrage asymmetry at each month is measured in two ways. The first one is the innovation in the difference between the two half-Amihud measures - the half-Amihud measure for down days minus the half-Amihud measure for up days. Brennan, Hur, and Subrahmanyam (2013) presume that illiquidity for up market and down market can be different from each other, and then empirically show that the half-Amihud illiquidity measures for down days tend to be greater than those for up days. This result is apparently consistent with the notion that shorting is more costly and difficult; it can be regarded as the empirical evidence confirming the presence of arbitrage asymmetry. Hence, we use herein their half-Amihud illiquidity measures to proxy arbitrage asymmetry of the aggregate market. In particular, at each month, we compute both half-Amihud

measures for down days and up days for each stock, and average the difference between the two measures across all stocks. We then obtain the innovations in the differences from the AR (2) specifications using the whole sample.[8] Note that we expect that the innovation is positively related to the level of aggregate arbitrage asymmetry.

The second approach to proxy market-wide arbitrage asymmetry is inspired by Chen, Hong, and Stein (2002) who document that stocks with lower change in breadth earn lower subsequent returns. They suggest a model where low breadth signals that short-sale constraints are binding tightly, and provide the empirical evidence supporting that breadth of ownership is a valuation indicator. That is, they show that change in breadth can be indicative of the extent to which short-sale is constrained, i.e., the difficulty of short selling. Following such implication, we use the average change in breadth of institutional ownership across stocks as a proxy for market-wide arbitrage asymmetry. The change in the breadth of institutional ownership for each stock is computed according to Lehavy and Sloan (2008).[9] Note that we find that the two market-wide arbitrage asymmetry measures are significantly time-varying over time and positively correlated each other in unreported results.

Our sample consists of all firms listed on NYSE, AMEX, and NASDAQ during the period of 1996 through 2010 with available monthly returns in Center for Research in Security Prices (CRSP).[10] The sample period is limited by the availability of Optionmetrics dataset, which provides daily trading volume for all exchange-traded put options from January 1996. Institutional holdings are obtained from Thomson Reuters' 13F database.[11] Other data necessary for constructing anomaly-based long-

[8] We compute the two half-Amihud measures following Brennan, Hur, and Subrahmanyam (2013). Since we observe distinctive time trends for the average difference between these two measures, we extract residuals or trend-adjusted measures for the two raw measures.

[9] Lehavy and Sloan (2008) compute the breadth of ownership using institutional holding data instead of mutual fund holding data used by Chen, Hong, and Stein (2002). Note that institutional holding data are provided on a quarterly basis, so the change in breadth in each quarter is assigned to each month in that quarter. Breadth of ownership for each stock in each quarter is defined as the ratio of the number of institutions that hold a long position in the stock to the total number of institutions in the sample for that quarter.

[10] Note that depending on the availability of an anomaly-sorting variable, the number of firms included in the sample can be varied. The details of average number of firms for each anomaly are provided in Table 2.

[11] Thomson Reuters' institutional holding database is based on 13F filings made with the SEC. Any institutional investors with more than $100 million of securities under their discretion is required to make a quarterly filing of a 13F for every security holding in excess of $200,000 or 10,000 shares.

short strategies come from Compustat.

< Insert here Table 1>

Table 1 reports average monthly returns on the long- and short-legs as well as the long-short portfolios in months following high-sentiment and low-sentiment across all stocks. Note that each long-short strategy involves buying one extreme decile portfolio and selling the opposite extreme decile portfolio, with the long-leg being the higher-performing decile and the short-leg being the lower-performing decile. We measure investor sentiment using the monthly sentiment index devised by Baker and Wurgler (2006), and classify a high-sentiment month as the one in which the sentiment index values in the previous month is above the sample median, while a low-sentiment month is that with below-median value, following prior studies.[12]

The first four columns of Table 1 exhibit results for excess returns, and the next four columns reports results for returns adjusted by the three Fama and French (1993) factors. The risk-adjusted returns following high- and low-sentiment periods are estimates of a_H and a_L in the following regression,

$$r_{i,t} = a_H d_{H,t} + a_L d_{L,t} + bMKT_t + sSMB_t + hHML_t + \varepsilon_{i,t} \quad (1)$$

where $d_{H,t}$ and $d_{L,t}$ are dummy variables indicating high- and low-sentiment periods, and $r_{i,t}$ is the excess return in month t on either the long-leg, the short-leg, or the long-short portfolio.

Table 1, as a whole, confirms the findings of prior studies. Almost all the long-short portfolios exhibit higher average returns following high sentiment than following low sentiment. Moreover, the profits following high sentiment seem to largely come from their short-legs. Specifically, the short-leg of the anomaly-based strategy earns significantly lower risk-adjusted returns following high sentiment than low sentiment, on average. On the other hand, the risk-adjusted returns on the long-leg are not

[12] Baker and Wurgler (2006) construct the index as the first principal component of six underlying proxies of investor sentiment: trading volume, dividend premium, closed-end fund discount, number and first day returns in IPO's, and the equity share in new issues.

significantly different between following high- and low-sentiment. These results imply that sentiment has appreciable influence on the short-leg during periods of high sentiment, but has little effect on the long-leg regardless of investor sentiment. Collectively, the evidence in Table 1, appears to support an inference that the anomalies may reflect mispricing, where sentiment-induced overpricing is more prevalent than sentiment-induced underpricing.

3. Empirical results

Our interest is a role of asymmetric impediments to arbitrage in sentiment effects on asset prices. We will first examine how the cross-sectional difference of difficulty in exploiting negative information affects the profits of anomaly portfolios by comparing put-optioned stocks with non-put-optioned stocks. Next, we will look at how the market-wide asymmetry of arbitrage affects the time-series behavior of returns on the short-legs of anomaly portfolios using the price-impact and breadth measures.

3.1. Cross-sectional variations in arbitrage asymmetry

In this subsection, we examine whether the cross-sectional difference in arbitrage impediments exert influence on the relation between sentiment and stock returns. Inspired by prior studies documenting that put options can reduce shorting costs, we divide our sample into stocks with and without tradable put options, and then compare the profits of anomaly-based strategies between these two subsamples. If arbitrage asymmetry is associated with sentiment-return relations, the strategies constructed with non-put-optioned stocks exhibit greater asymmetry in mispricing than those with put-optioned stocks.

<Insert here Table 2>

Table 2 presents the descriptive statistics for both subsamples. First, the number of put-optioned stocks is, on average, not much different from that of non-put-optioned stocks, which indicates both subsamples have sufficient stocks to implement long-short anomaly strategies. Second, the non-put-optioned subsample tends to contain smaller firms compared to the put-optioned subsample. Some may argue that our later analyses on the differences between the put-optioned and non-put-optioned subsamples may be due to the size difference between the two subsamples. However, since the market capitalization itself can be a proxy for the arbitrage asymmetry, and our main concern lies only in the arbitrage asymmetry, we believe that the conclusions drawn from the differences between the two subsamples will stand. Lastly, little evidence exists for the significant difference in book-to-market ratios between the two subsamples.

<Insert here Table 3>

Table 3 reports returns on the long-short strategies based on thirteen anomalies for the non-put-optioned and the put-optioned subsample, respectively. Panel A presents returns in excess of risk-free rate, and Panel B presents returns adjusted by the three Fama and French factors. Recall that in favor of a role of arbitrage asymmetry in the sentiment-return relation, we expect that the asymmetric effect of sentiment would be more pronounced among stocks with tradable put options. Since non-put-optioned stocks have presumably the higher degree of arbitrage asymmetry, they may be susceptible to overpricing more often than underpricing.

Table 3 apparently supports such prediction. Both panels reveal that within the non-put-optioned subsample, the profitability of long-short anomaly-based strategies is pronounced following high sentiment than following low sentiment. The long-short portfolios earn significantly higher risk-adjusted returns following high sentiment than following low sentiment for 9 out of 13 anomalies. On

the other hand, within the put-optioned subsample, such tendency is quite weaker. For 9 out of 13 anomalies, the long-short portfolios do not earn significantly higher returns following high sentiment than following low sentiment.

These results are quite consistent with our hypothesis that arbitrage asymmetry, i.e., the relative difficulty of shorting versus purchasing drives the asymmetric effect of sentiment. Since arbitrageurs can exploit overpricing at a relatively low cost when tradable put options are available, those stocks are less likely to be overpriced. As a result, the long-short strategies constructed among stocks with tradable put options are also less likely to exhibit asymmetry in mispricing.

Columns 7-9 in Table 3 lend support to this inference. They present the difference in profits of long-short strategies between the two subsamples. In months following high sentiment, the long-short strategies constructed among non-put-optioned stocks are more profitable than those among put-optioned stocks. Since stocks with higher asymmetry in impediments are more likely to be overpriced, the long-short strategies among them earn higher profits.

Interestingly, the difference in profits of long-short strategies between the two subsamples is, in general, insignificant in months following low sentiment. When market sentiment is low, i.e. when there is a tendency of underpricing, arbitrage trading involves not shorting but purchasing, and hence, shoring costs exert little influence on asset prices at those times. Consequently, the profit between the two subsamples does not exhibit significant difference following low sentiment. Our empirical evidence confirms it.

<Insert here Table 4>

Table 4 reports returns on the short- and long-leg for each subsample.[13] As discussed earlier, we conjecture that the short-leg is likely to be overpriced due to its high shorting costs. If this is the case,

[13] We report risk-adjusted returns only since the analysis using excess returns yield consistent results.

the profitability of long-short strategies within the non-put-optioned subsample should largely come from the short-leg. Consistent with our conjecture, within the non-put-optioned subsample, profits on the short-legs comprise a large portion of those on the long-short portfolios following high sentiment, in general. Moreover, the short-legs of the non-put-optioned stocks exhibit greater asymmetry in mispricing than those of the put-optioned stocks. Specifically, they earn significantly negative returns following high sentiment, but not following low sentiment. These results, considered collectively, indicate that the short-leg contains stocks relatively difficult or costly to short compared to the long-leg.

In sum, we find that the cross-sectional difference of difficulty in exploiting negative information plays an appreciable role in asymmetry in mispricing. Stocks with higher shorting costs exhibit higher asymmetry in sentiment-return relation; they are more likely to be overpriced in periods of high sentiment but are less likely to be underpriced in periods of low sentiment. On the other hand, we can find little evidence that stocks with low shorting costs exhibit asymmetry in mispricing; they are less susceptible to mispricing regardless of investor sentiment.

3.2. Time-series variations in arbitrage asymmetry

In this subsection, we consider the time-series variation in arbitrage asymmetry. Several extant studies suggest that the relative difficulty of shorting versus buying can be time-varying. For example, Brennan et al. (2012) document that the price impact of a sell-order is greater than that of a buy-order throughout their sample period, and more interestingly, find that the average difference between sell- and buy-order illiquidity varies over time; it co-moves with market conditions such as funding illiquidity.

With a reasonable assumption of time-varying arbitrage asymmetry, we conjecture that when market-wide arbitrage asymmetry is severe, returns are significantly related to investor sentiment. In

particular, we expect returns on the short-legs of anomaly-based strategies, presumably more costly to short, are more negatively related to lagged sentiment.

To investigate this conjecture, we run the following predictive regression:

$$r_{i,t} = a + b_H D_{H,t-1} S_{t-1} + b_L D_{L,t-1} S_{t-1} + sMKT_t + sSMB_t + hHML_t + u_{i,t} \quad (2)$$

where $D_{H,t}$ $(D_{L,t})$ is the dummy variable set equal to one if the measure of market-wide arbitrage asymmetry at month t is above (below) the median value for the sample period, and zero otherwise. $r_{i,t}$ is the excess return in month t on either the long-leg, the short-leg, or the long-short portfolio, and S_{t-1} is the Baker and Wurgler sentiment index at month t-1.[14]

This regression allows us to compare the effect of sentiment on returns between the high- and low-arbitrage-asymmetry periods. The significance of the slope coefficients, b_H and b_L, indicates when or the extent to which market-wide arbitrage asymmetry influences the effects of sentiment on stock returns. In this regards, i.e., in that considering the time-variation in sentiment-return relations, our approach is differentiated from those of prior studies.[15]

<Insert here Table 5>

As mentioned earlier, we use two measures to proxy the degree of market-wide arbitrage asymmetry. One is the price-impact measure defined as the innovation in the difference between aggregate illiquidity for down- and up-days, and the other is the breadth measure defined as the average change in breadth of institutional ownership.

Panel A of Table 5 presents the estimates of the slope coefficients, b_H and b_L in equation (2) when

[14] Novy-Marx (2012) argues that when using the Baker and Wurgler index as an independent variable in time-series regression, spurious-regressor concern can arise. As for this issue, Stambaugh, Yu, and Yuan (2012b) reveal that such concern is diminished when considering the ability of such a regressor to generate predicted results across a number of regressions.

[15] Chung, Hung, and Yeh (2012) document that only in the expansion state does sentiment perform predictive power for the returns of various portfolios. They segregate economic states according to the NBER business cycle and a Markov-switching model. Their results do not contradict to ours in that the states of the economy are not necessary to correlate with market-wide arbitrage asymmetry.

using the price-impact measure for the market-wide arbitrage asymmetry dummies. Notably, we find little evidence that returns on the long-legs, the short-legs, and the long-short portfolios are related to sentiment except for the short-legs of the non-put-optioned subsample. Even within the non-put-optioned subsample, b_L*'s* for the short-legs are not significant at all for most anomalies. Just b_H*'s* for the short-legs in the non-put-optioned subsample are significant and negative. These results are quite consistent with our conjecture that stock prices can be affected by investor sentiment in the presence of arbitrage asymmetry in the cross-section as well as in the time-series. Even for non-put-optioned stocks, i.e., stocks seemingly costly to short, their prices are not influenced by investor sentiment when market-wide shorting costs are not high. That is, the time-variation in asymmetric impediments to arbitrage do matter in sentiment-driven mispricing. The results reported in Panel B are qualitatively the same as those in Panel A. That is, regardless of the measures of market-wide arbitrage asymmetry, we obtain consistent evidence.

In short, we find evidence that arbitrage asymmetry plays a crucial role in the asymmetric effect of sentiment on stock prices in the cross-section as well as in the time-series. The long-short strategies among put-optioned stocks exhibit greater asymmetry in mispricing than those among non-put-optioned stocks. Even the short-legs constructed within the non-put-optioned subsamples, i.e., stocks that are presumably costly to short, do not exhibit significant relation with investor sentiment when market-wide arbitrage asymmetry is low.

3.3. Discussions

Recently, a growing body of literature has attempted to find out the single source driving a broad set of asset-pricing anomalies.[16] Many of them entertain the possibility that mispricing is the primary

[16] For example, Novy-Marx (2013) and Chen, Novy-Marx, and Zhang (2010) has tried to explain anomalies with risk premia. Novy-Marx

source of the anomalies. In this subsection, in accordance with their view, we explore anomalies and discuss whether or the extent to which they are associated with mispricing induced by high shorting costs. If the anomaly stems from the difficulty of shorting, profits based on them will be concentrated among stocks with higher shorting cost, and hence, likely to be overpriced. Therefore, for all anomalies herein considered, we determine the extent of their relevance to mispricing on the basis of their degree of asymmetry in mispricing especially within the non-put-optioned subsample.

Table 3 reveals that the returns on anomaly-based strategies related to composite stock issue, investment-to-asset, asset growth, net operating assets, and total accruals, in general, exhibit less asymmetric patterns across investor sentiment. Within the non-put-optioned subsample, the long-short strategies based on these five anomalies are not more profitable following high sentiment than following low sentiment. Moreover, in months following high sentiment, returns on the long-short strategies within the non-put-optioned subsample are not greater than those within the put-optioned subsample. Table 5 also confirms such inference. Unlike other anomalies, returns on the short-legs based on those five are not significantly related to lagged sentiment even when market-wide arbitrage asymmetry is high.

In sum, we find no or little evidence that anomalies related to composite stock issue, investment-to-asset, asset growth, net operating assets, and total accruals are associated with overpricing induced by high shorting costs. Interestingly, there are several studies documenting the commonality across those anomalies. For example, Li and Zhang (2010) argue that anomalies related to composite stock issue, investment-to-asset, asset growth, net operating assets, and total accruals are closely linked each other since they all have to do something with the real investment; to put it bluntly, they can be inherently almost the same. Meanwhile, some studies including Wu, Zhang, and Zhang (2010) and Chan, Novy-Marx, and Zhang (2011) argue that those anomalies can be explained in terms of an additional risk

(2013) argue that a wide set of anomalies can be explained by the relation to gross profitability premium to some extent. Chen, Novy-Marx, and Zhang (2010) suggest the alternative three factor model. On the other hand, Stambaugh, Yu, and Yuan (2012a, 2012c) argue that sentiment-induced overpricing can be a partial explanation for anomalies. Avramov et al. (2013) also argue the profitability of most anomalies stems from mispricing of worst-rated stocks around periods of financial distress.

such as an investment risk. For example, Chan, Novy-Marx, and Zhang (2011) document that controlling the exposure to a return-on-equity factor or an investment factor, the magnitude of their abnormal returns is reduced often to insignificance. The findings of relevant studies and our empirical results suggest the possibility that the five anomalies mentioned above have something in common and are not associated with overpricing due to high shorting costs. We cannot say, at the least, that all the anomalies definitely stem from the difficulty in exploiting negative information.

4. Conclusions

Miller hypothesizes that assets tend to be overpriced when there are short-sale restrictions, and SSY push this idea further, documenting that the short-legs of long-short portfolios examined in the anomaly literature are the main drivers of the anomalies and those anomalous profits of the short-legs appear mainly in high-sentiment periods. Our study extends SSY and tests whether short-sale constraints are indeed the culprits of those anomaly profits.

We document the followings. First, put-optioned stocks, which are supposed to be less costly to short, have less anomaly profits than non-put-optioned stocks. Second, in high sentiment periods, short-legs of anomaly portfolios are more profitable with put-optioned stocks than non-put-optioned stocks, while, in low sentiment periods, short-legs are not profitable with both groups of stocks. Third, returns on short-legs of anomaly portfolios are negatively related to lagged sentiment only when the market-wide degree of arbitrage asymmetry is high, where arbitrage asymmetry is measured by the difference of the market impact costs between the up market and the down market or by the market-wide average change in breadth. Finally, anomalies associated with capital investments do not stem from short-sale constraints. We have not found evidence supporting that anomalies related to composite stock issue, investment-to-asset, asset growth, net operating assets, and total accruals are negatively related to lagged sentiment when market-wide arbitrage asymmetry is high, even within the non-put-optioned

stocks. Thus, many of the anomalies seem to be caused by short-sale constraints, i.e., arbitrage asymmetry, but some of the anomalies, especially capital investment related anomalies, cannot be accounted for by the presence of short-sale constraints.

Our evidence suggests that many of the anomalies are caused by short-sale constraints and so there is a strong possibility that it is difficult to exploit these anomalies in practice, even when these anomalies result from mispricing in the market.

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Table 1

Profits on anomaly-based strategies

This table reports average excess returns (Panel A) and risk-adjusted returns (Panel B) for the short-leg, the long-leg, or the long-short portfolio based on thirteen anomalies. The risk-adjusted returns in high- and low-sentiment periods are estimates of a_H and a_L in the regression,

$$r_{i,t} = a_H d_{H,t} + a_L d_{L,t} + bMKT_t + sSMB_t + hHML_t + \epsilon_{i,t}$$

where $d_{H,t}$ and $d_{L,t}$ are dummy variables indicating high- and low-sentiment periods, and $r_{i,t}$ the excess return in month t on either the short-, the long-, or the long-short portfolio. The sample period is from January 1996 through December 2011. All returns are percent per month and all t-statistics given in parentheses are adjusted based on Newy-West (1987).

	Long-leg			Short-leg			Long-Short		
	High	Low	H - L	High	Low	H - L	High	Low	H - L
Panel A. Excess returns									
(1) Analyst disagreement	0.66	1.13	-0.47	-0.40	2.31	-2.71	1.06	-1.18	2.24
	(1.43)	(2.13)	(-0.63)	(-0.49)	(2.24)	(-2.04)	(2.13)	(-1.95)	(2.79)
(2) Credit rating	0.43	0.92	-0.49	-1.13	2.67	-3.80	1.56	-1.75	3.31
	(1.03)	(1.62)	(-0.71)	(-1.23)	(2.12)	(-2.46)	(2.01)	(-2.09)	(2.74)
(3) Failure probability	0.66	1.70	-1.04	-0.99	1.91	-2.89	1.64	-0.21	1.85
	(1.40)	(3.02)	(-1.38)	(-1.25)	(2.01)	(-2.27)	(3.19)	(-0.39)	(2.33)
(4) Ohlson's O-score	0.44	1.76	-1.32	-1.07	2.14	-3.21	1.51	-0.38	1.89
	(0.64)	(2.53)	(-1.25)	(-1.51)	(2.42)	(-2.79)	(4.59)	(-0.74)	(3.25)
(5) Momentum	1.14	2.09	-0.95	-1.52	2.15	-3.66	2.65	-0.06	2.71
	(1.34)	(2.57)	(-0.74)	(-1.64)	(1.83)	(-2.42)	(3.27)	(-0.07)	(2.13)
(6) Return on equity	0.78	2.06	-1.28	-1.53	2.08	-3.61	2.30	-0.02	2.33
	(1.34)	(3.17)	(-1.40)	(-1.56)	(1.98)	(-2.37)	(3.91)	(-0.05)	(2.65)
(7) Gross profitability	0.93	2.33	-1.41	-0.98	1.58	-2.56	1.90	0.76	1.15
	(1.53)	(3.32)	(-1.47)	(-1.17)	(2.03)	(-2.03)	(4.55)	(2.37)	(1.89)
(8) Net stock issues	0.82	1.62	-0.80	-0.52	1.37	-1.89	1.33	0.24	1.09
	(1.86)	(2.68)	(-1.08)	(-0.79)	(1.80)	(-1.81)	(3.68)	(0.83)	(2.06)
(9) Composite stock issues	0.38	1.91	-1.53	-0.25	1.52	-1.77	0.63	0.39	0.24
	(0.85)	(2.64)	(-1.90)	(-0.37)	(1.91)	(-1.64)	(1.53)	(0.85)	(0.37)
(10) Investment-to-assets	0.06	1.60	-1.54	-0.86	1.54	-2.41	0.93	0.05	0.87
	(0.10)	(2.09)	(-1.49)	(-1.27)	(2.14)	(-2.29)	(3.90)	(0.22)	(2.39)
(11) Asset growth	-0.08	2.44	-2.52	-1.06	1.32	-2.39	0.98	1.12	-0.13
	(-0.12)	(2.75)	(-2.20)	(-1.24)	(1.78)	(-1.87)	(2.38)	(3.66)	(-0.22)
(12) Net operating assets	0.26	1.75	-1.49	-0.53	1.54	-2.07	0.79	0.21	0.58
	(0.42)	(2.68)	(-1.56)	(-0.90)	(2.21)	(-2.20)	(2.52)	(0.61)	(1.18)
(13) Total accruals	0.19	2.54	-2.36	-1.02	1.40	-2.42	1.20	1.14	0.06
	(0.24)	(3.08)	(-1.93)	(-1.34)	(1.82)	(-2.08)	(5.53)	(4.53)	(0.18)
Panel B. Risk-adjusted returns									
(1) Analyst disagreement	0.38	-0.02	0.40	-0.74	0.14	-0.88	1.12	-0.16	1.28
	(2.19)	(-0.10)	(1.52)	(-2.89)	(0.54)	(-2.26)	(3.76)	(-0.46)	(2.70)
(2) Credit rating	0.12	0.10	0.02	-1.54	0.25	-1.79	1.66	-0.15	1.81
	(0.92)	(0.65)	(0.12)	(-4.15)	(0.57)	(-3.03)	(3.92)	(-0.30)	(2.69)
(3) Failure probability	0.42	0.47	-0.06	-1.22	-0.05	-1.17	1.64	0.52	1.11
	(2.66)	(2.47)	(-0.24)	(-3.92)	(-0.14)	(-2.37)	(4.31)	(1.15)	(1.82)
(4) Ohlson's O-score	0.39	0.31	0.08	-1.36	0.30	-1.66	1.75	0.01	1.75
	(2.10)	(2.12)	(0.31)	(-5.08)	(0.83)	(-3.71)	(6.18)	(0.02)	(3.56)
(5) Momentum	0.99	0.20	0.79	-1.77	0.12	-1.89	2.76	0.08	2.68
	(2.88)	(0.58)	(1.48)	(-3.33)	(0.24)	(-2.34)	(3.49)	(0.10)	(2.22)
(6) Return on equity	0.53	0.62	-0.09	-1.65	-0.14	-1.51	2.18	0.76	1.42
	(2.75)	(3.16)	(-0.32)	(-5.17)	(-0.37)	(-2.93)	(6.17)	(1.84)	(2.51)
(7) Gross profitability	0.71	0.80	-0.09	-1.10	-0.27	-0.83	1.80	1.06	0.74
	(3.73)	(4.04)	(-0.31)	(-3.82)	(-0.83)	(-1.86)	(5.60)	(2.67)	(1.45)
(8) Net stock issues	0.45	0.38	0.07	-0.78	-0.29	-0.49	1.23	0.67	0.56
	(2.89)	(1.95)	(0.29)	(-3.77)	(-1.49)	(-1.61)	(5.89)	(2.84)	(1.69)
(9) Composite stock issues	-0.02	0.60	-0.62	-0.50	-0.23	-0.28	0.48	0.83	-0.35
	(-0.11)	(2.22)	(-1.97)	(-2.51)	(-1.08)	(-0.89)	(1.88)	(2.51)	(-0.78)
(10) Investment-to-assets	-0.15	-0.06	-0.09	-1.07	-0.10	-0.97	0.92	0.04	0.88
	(-0.75)	(-0.25)	(-0.29)	(-4.46)	(-0.51)	(-2.81)	(3.86)	(0.18)	(2.49)
(11) Asset growth	-0.39	0.54	-0.94	-1.13	-0.46	-0.67	0.73	1.00	-0.27
	(-1.59)	(2.14)	(-2.49)	(-4.25)	(-1.72)	(-1.67)	(2.27)	(3.22)	(-0.55)
(12) Net operating assets	0.12	0.29	-0.17	-0.88	-0.02	-0.85	0.99	0.31	0.69
	(0.60)	(1.17)	(-0.54)	(-4.29)	(-0.09)	(-2.70)	(3.77)	(1.03)	(1.69)
(13) Total accruals	0.01	0.68	-0.67	-1.21	-0.38	-0.82	1.21	1.06	0.15
	(0.02)	(3.09)	(-1.85)	(-4.71)	(-1.43)	(-2.15)	(5.52)	(4.33)	(0.45)

Table 2
Descriptive statistics
This table reports descriptive statistics for two subsamples divided by the availability of tradable put options. The non-put-optioned subsample consists of stocks without tradable put options, while the put-optioned subsample contains those with tradable put options. The sample period is from January 1996 through December 2011.

		Number of firms		Market Capitalization ($mil.)				Book-to-market			
		non-put-optioned	put-optioned	non-put-optioned		put-optioned		non-put-optioned		put-optioned	
				Long-leg	Short-leg	Long-leg	Short-leg	Long-leg	Short-leg	Long-leg	Short-leg
(1)	Analyst disagreement	924	1,606	622	583	12,331	2,027	0.57	0.91	0.37	0.72
(2)	Credit rating	283	934	11,140	358	40,044	1,718	0.78	1.22	0.43	0.72
(3)	Failure probability	2,251	1,840	575	145	7,286	2,054	0.67	1.01	0.44	0.70
(4)	Ohlson's O-score	1,663	1,634	517	150	15,969	797	0.53	0.81	0.33	0.59
(5)	Momentum	2,545	1,959	319	181	3,713	2,089	0.49	1.13	0.33	0.75
(6)	Return on equity	2,484	1,957	373	204	11,279	1,577	0.42	0.73	0.24	0.53
(7)	Gross profitability	1,972	1,860	236	521	5,760	4,303	0.54	0.80	0.33	0.58
(8)	Net stock issues	1,719	1,560	574	498	7,812	5,527	1.10	0.63	0.58	0.47
(9)	Composite stock issues	1,592	1,478	316	426	7,534	5,037	1.12	0.68	0.62	0.51
(10)	Investment-to-assets	1,462	1,553	226	344	1,885	3,288	0.82	0.75	0.52	0.49
(11)	Asset growth	2,427	1,940	233	396	3,155	4,321	0.99	0.48	0.71	0.33
(12)	Net operating assets	2,163	1,581	255	345	4,008	3,081	0.60	0.78	0.34	0.55
(13)	Total accruals	1,330	1,282	207	177	3,041	2,061	0.73	0.55	0.49	0.39

Table 3

Returns on long-short strategies: non-put-optioned vs. put-optioned

This table reports average returns on the long-short strategies based on thirteen anomalies for each subsample as well as the return difference between the two subsamples. The non-put-optioned subsample consists of stocks with tradable put options, while the put-optioned subsample contains those without tradable put options The risk-adjusted returns in high- and low-sentiment periods are estimates of a_H and a_L in the regression,

$$r_{i,t} = a_H d_{H,t} + a_L d_{L,t} + bMKT_t + sSMB_t + hHML_t + \epsilon_{i,t}$$

where $d_{H,t}$ and $d_{L,t}$ are dummy variables indicating high- and low-sentiment periods, and $r_{i,t}$ the excess return in month t on either the short-, the long-, or the long-short portfolio. The sample period is from January 1996 through December 2011. All returns are percent per month and all t-statistics given in parentheses are adjusted based on Newy-West (1987).

	Non-put-optioned			Put-optioned			Difference		
	High	Low	H - L	High	Low	H - L	High	Low	H - L
Panel A. Excess returns									
(1) Analyst disagreement	1.80	-0.67	2.49	0.55	-1.39	1.95	1.27	0.73	0.55
	(3.87)	(-1.27)	(3.39)	(0.97)	(-2.05)	(2.13)	(3.72)	(1.67)	(0.98)
(2) Credit rating	1.89	-2.45	4.36	1.31	-1.49	2.80	0.61	-0.96	1.57
	(2.64)	(-2.09)	(3.34)	(1.37)	(-1.86)	(2.00)	(1.01)	(-1.07)	(1.50)
(3) Failure probability	2.12	0.28	1.87	0.91	-0.75	1.66	1.24	1.03	0.22
	(4.75)	(0.55)	(2.66)	(1.23)	(-1.00)	(1.47)	(2.86)	(1.84)	(0.30)
(4) Ohlson's O-score	2.33	0.46	1.92	1.06	-0.92	1.98	1.32	1.39	-0.06
	(7.73)	(0.91)	(3.48)	(2.35)	(-1.69)	(2.74)	(3.04)	(2.79)	(-0.09)
(5) Momentum	3.54	0.75	2.84	1.69	-1.10	2.79	1.89	1.85	0.04
	(4.76)	(0.90)	(2.41)	(1.84)	(-1.10)	(1.95)	(3.88)	(4.07)	(0.06)
(6) Return on equity	3.21	0.86	2.40	1.22	-0.74	1.96	2.05	1.60	0.45
	(5.57)	(1.71)	(2.80)	(1.79)	(-1.21)	(1.93)	(5.22)	(3.73)	(0.73)
(7) Gross profitability	1.99	0.98	1.08	1.72	0.52	1.20	0.33	0.45	-0.12
	(5.33)	(3.15)	(1.98)	(3.14)	(1.15)	(1.49)	(0.92)	(0.99)	(-0.20)
(8) Net stock issues	1.52	0.15	1.37	1.04	0.18	0.86	0.49	-0.03	0.52
	(4.61)	(0.43)	(2.68)	(2.27)	(0.60)	(1.32)	(1.61)	(-0.09)	(1.10)
(9) Composite stock issues	1.02	0.13	0.90	0.21	0.50	-0.29	0.83	-0.36	1.19
	(2.48)	(0.26)	(1.34)	(0.46)	(1.15)	(-0.43)	(2.86)	(-1.06)	(2.58)
(10) Investment-to-assets	0.86	0.11	0.74	1.00	0.12	0.87	-0.14	-0.01	-0.13
	(3.59)	(0.39)	(1.91)	(2.95)	(0.44)	(1.77)	(-0.39)	(-0.02)	(-0.25)
(11) Asset growth	0.76	1.31	-0.58	1.35	0.83	0.53	-0.62	0.49	-1.10
	(2.16)	(3.73)	(-1.07)	(2.64)	(2.33)	(0.72)	(-1.58)	(1.44)	(-1.92)
(12) Net operating assets	0.67	0.01	0.64	0.97	0.54	0.43	-0.32	-0.54	0.22
	(2.45)	(0.02)	(1.43)	(1.89)	(1.08)	(0.55)	(-0.78)	(-1.11)	(0.33)
(13) Total accruals	0.98	1.19	-0.24	1.31	1.14	0.18	-0.37	0.05	-0.42
	(3.81)	(3.75)	(-0.57)	(4.38)	(3.16)	(0.37)	(-1.06)	(0.11)	(-0.74)
Panel B. Risk-adjusted returns									
(1) Analyst disagreement	1.85	0.17	1.71	0.60	-0.28	0.88	1.28	0.46	0.83
	(5.82)	(0.44)	(3.37)	(1.72)	(-0.70)	(1.60)	(3.78)	(1.17)	(1.58)
(2) Credit rating	2.20	-0.73	2.95	1.24	0.11	1.13	0.98	-0.84	1.82
	(4.64)	(-0.94)	(3.34)	(2.37)	(0.24)	(1.47)	(1.90)	(-1.09)	(2.01)
(3) Failure probability	2.11	0.87	1.28	0.91	0.48	0.43	1.24	0.39	0.85
	(6.05)	(1.94)	(2.24)	(1.94)	(0.88)	(0.58)	(3.70)	(0.83)	(1.53)
(4) Ohlson's O-score	2.47	0.80	1.73	1.26	-0.21	1.47	1.27	1.01	0.25
	(8.40)	(1.76)	(3.33)	(3.14)	(-0.50)	(2.39)	(2.89)	(2.21)	(0.39)
(5) Momentum	3.64	0.79	2.87	1.81	-0.86	2.67	1.86	1.66	0.20
	(5.07)	(1.15)	(2.55)	(2.02)	(-1.04)	(1.99)	(3.82)	(3.71)	(0.29)
(6) Return on equity	3.04	1.43	1.66	1.12	0.27	0.85	1.98	1.17	0.81
	(7.69)	(3.27)	(2.71)	(2.87)	(0.58)	(1.38)	(5.23)	(2.93)	(1.45)
(7) Gross profitability	1.87	1.07	0.86	1.63	1.08	0.56	0.31	0.00	0.31
	(5.80)	(2.93)	(1.77)	(4.09)	(2.07)	(0.86)	(0.96)	(0.00)	(0.60)
(8) Net stock issues	1.49	0.66	0.84	0.87	0.59	0.28	0.63	0.07	0.56
	(6.68)	(2.48)	(2.42)	(3.18)	(2.00)	(0.65)	(2.26)	(0.23)	(1.29)
(9) Composite stock issues	0.93	0.65	0.30	0.04	0.87	-0.83	0.91	-0.22	1.13
	(3.36)	(1.66)	(0.60)	(0.12)	(2.52)	(-1.70)	(3.11)	(-0.64)	(2.49)
(10) Investment-to-assets	0.88	0.09	0.78	0.95	0.04	0.90	-0.07	0.05	-0.12
	(3.58)	(0.33)	(2.05)	(2.74)	(0.15)	(1.86)	(-0.21)	(0.15)	(-0.23)
(11) Asset growth	0.59	1.12	-0.56	1.02	0.75	0.27	-0.46	0.37	-0.83
	(1.80)	(3.35)	(-1.12)	(2.87)	(1.83)	(0.48)	(-1.44)	(0.96)	(-1.68)
(12) Net operating assets	0.85	0.24	0.59	1.25	0.33	0.92	-0.42	-0.10	-0.33
	(3.44)	(0.80)	(1.55)	(3.37)	(0.77)	(1.59)	(-1.39)	(-0.23)	(-0.65)
(13) Total accruals	0.98	1.09	-0.15	1.33	1.09	0.24	-0.39	0.00	-0.39
	(3.68)	(3.55)	(-0.37)	(4.35)	(3.10)	(0.50)	(-1.11)	(0.00)	(-0.71)

Table 4

Returns on the long- and short-leg of anomaly-based strategies: non-put-optioned vs. put-optioned

This table reports average risk-adjusted returns on the long- and short-legs of strategies based on thirteen anomalies for each subsample as well as the return difference between the two subsamples. The non-put-optioned subsample consists of stocks with tradable put options, while the put-optioned subsample contains those without tradable put options. The risk-adjusted returns in high- and low-sentiment periods are estimates of a_H and a_L in the regression,

$$r_{i,t} = a_H d_{H,t} + a_L d_{L,t} + bMKT_t + sSMB_t + hHML_t + \epsilon_{i,t}$$

where $d_{H,t}$ and $d_{L,t}$ are dummy variables indicating high- and low-sentiment periods, and $r_{i,t}$ the excess return in month t on either the short-, the long-, or the long-short portfolio. The sample period is from January 1996 through December 2011. All returns are percent per month and all t-statistics given in parentheses are adjusted based on Newy-West (1987).

	Non-put-optioned			Put-optioned			Difference		
	High	Low	H - L	High	Low	H - L	High	Low	H - L
Panel A. Risk-adjusted returns on the long-legs									
(1) Analyst disagreement	-0.10	2.59	-2.71	0.38	2.47	-2.09	-0.50	0.12	-0.62
	(-0.13)	(3.25)	(-2.35)	(0.41)	**(2.71)**	(-1.49)	(-1.17)	(0.30)	(-0.97)
(2) Credit rating	0.40	0.05	0.36	0.37	-0.01	0.39	0.04	0.07	-0.02
	(2.02)	(0.21)	(1.17)	(1.82)	(-0.07)	(1.26)	(0.22)	(0.30)	(-0.07)
(3) Failure probability	0.33	-0.12	0.45	0.10	0.12	-0.02	0.23	-0.24	0.47
	(1.60)	(-0.45)	(1.29)	(0.75)	(0.79)	(-0.11)	(1.21)	(-0.84)	(1.36)
(4) Ohlson's O-score	0.69	0.82	-0.13	0.19	0.20	-0.01	0.50	0.62	-0.12
	(4.15)	(3.59)	(-0.49)	(0.96)	(0.91)	(-0.04)	(2.76)	(2.72)	(-0.41)
(5) Momentum	0.95	0.98	0.00	0.29	0.16	0.12	0.70	0.82	-0.12
	(4.17)	(4.21)	(-0.01)	(1.38)	(1.06)	(0.41)	(2.87)	(3.20)	(-0.34)
(6) Return on equity	1.06	0.50	0.57	0.85	-0.45	1.29	0.22	0.94	-0.73
	(2.91)	(1.29)	(0.98)	(2.25)	(-1.15)	(2.22)	(0.69)	(2.55)	(-1.45)
(7) Gross profitability	0.80	1.15	-0.34	0.32	0.26	0.06	0.49	0.89	-0.40
	(3.20)	(4.10)	(-0.87)	(1.63)	(1.34)	(0.21)	(2.24)	(3.72)	(-1.16)
(8) Net stock issues	0.58	1.04	-0.44	0.81	0.49	0.32	-0.21	0.55	-0.76
	(2.42)	(3.83)	(-1.19)	(3.60)	(2.21)	(0.95)	(-0.78)	(1.78)	(-1.81)
(9) Composite stock issues	0.39	0.42	-0.03	0.38	0.21	0.18	0.01	0.21	-0.21
	(1.95)	(1.73)	(-0.10)	(2.22)	(0.88)	(0.61)	(0.03)	(0.72)	(-0.60)
(10) Investment-to-assets	-0.01	0.57	-0.59	-0.09	0.49	-0.57	0.07	0.09	-0.02
	(-0.06)	(1.68)	(-1.57)	(-0.36)	(1.73)	(-1.53)	(0.29)	(0.30)	(-0.05)
(11) Asset growth	-0.30	0.05	-0.37	0.01	-0.27	0.28	-0.33	0.32	-0.65
	(-1.16)	(0.17)	(-0.90)	(0.05)	(-1.04)	(0.66)	(-0.91)	(0.94)	(-1.22)
(12) Net operating assets	-0.72	0.71	-1.47	0.11	0.25	-0.14	-0.86	0.47	-1.33
	(-2.29)	(1.98)	(-3.00)	(0.43)	(0.92)	(-0.34)	(-2.65)	(1.23)	(-2.63)
(13) Total accruals	-0.01	0.37	-0.40	0.33	0.06	0.27	-0.36	0.31	-0.67
	(-0.04)	(1.28)	(-1.16)	(1.17)	(0.21)	(0.63)	(-1.24)	(0.93)	(-1.48)
Panel B. Risk-adjusted returns on the short-legs									
(1) Analyst disagreement	-1.08	1.41	-2.47	-0.93	1.34	-2.27	-0.13	0.07	-0.20
	(-1.53)	(1.86)	(-2.23)	(-1.03)	(1.62)	(-1.68)	(-0.35)	(0.19)	(-0.35)
(2) Credit rating	-1.45	-0.12	-1.34	-0.23	0.27	-0.50	-1.24	-0.39	-0.85
	(-5.21)	(-0.35)	(-2.98)	(-0.71)	(0.92)	(-1.04)	(-3.68)	(-1.05)	(-1.64)
(3) Failure probability	-1.87	0.61	-2.50	-1.14	0.01	-1.15	-0.75	0.60	-1.35
	(-4.74)	(0.85)	(-3.29)	(-2.38)	(0.02)	(-1.67)	(-1.54)	(0.84)	(-1.62)
(4) Ohlson's O-score	-1.42	-0.04	-1.41	-0.72	-0.28	-0.44	-0.74	0.24	-0.97
	(-4.26)	(-0.11)	(-2.62)	(-1.86)	(-0.69)	(-0.74)	(-1.99)	(0.51)	(-1.65)
(5) Momentum	-1.51	0.19	-1.73	-0.97	0.38	-1.35	-0.57	-0.19	-0.38
	(-5.19)	(0.48)	(-3.56)	(-2.45)	(0.92)	(-2.26)	(-1.41)	(-0.49)	(-0.64)
(6) Return on equity	-2.58	-0.30	-2.31	-0.96	0.41	-1.38	-1.64	-0.71	-0.93
	(-5.28)	(-0.56)	(-2.95)	(-1.55)	(0.78)	(-1.51)	(-4.24)	(-1.96)	(-1.65)
(7) Gross profitability	-2.24	-0.28	-2.00	-0.80	-0.01	-0.79	-1.49	-0.28	-1.21
	(-5.84)	(-0.60)	(-3.21)	(-2.44)	(-0.02)	(-1.55)	(-3.93)	(-0.66)	(-2.13)
(8) Net stock issues	-1.28	-0.03	-1.31	-0.82	-0.58	-0.24	-0.52	0.55	-1.07
	(-4.13)	(-0.09)	(-2.78)	(-2.42)	(-1.53)	(-0.45)	(-1.63)	(1.60)	(-2.28)
(9) Composite stock issues	-1.10	-0.24	-0.87	-0.49	-0.38	-0.11	-0.62	0.14	-0.76
	(-5.11)	(-0.88)	(-2.48)	(-1.74)	(-1.66)	(-0.27)	(-2.23)	(0.48)	(-1.79)
(10) Investment-to-assets	-0.94	-0.08	-0.89	-0.12	-0.38	0.26	-0.84	0.30	-1.15
	(-3.95)	(-0.28)	(-2.32)	(-0.48)	(-1.73)	(0.70)	(-2.87)	(1.11)	(-2.65)
(11) Asset growth	-1.17	-0.04	-1.15	-0.93	-0.31	-0.62	-0.26	0.27	-0.53
	(-4.70)	(-0.13)	(-2.91)	(-3.02)	(-1.45)	(-1.46)	(-0.89)	(0.91)	(-1.21)
(12) Net operating assets	-1.31	-0.41	-0.91	-0.91	-0.50	-0.41	-0.41	0.10	-0.50
	(-4.55)	(-1.37)	(-2.06)	(-3.00)	(-1.72)	(-0.91)	(-1.35)	(0.35)	(-1.15)
(13) Total accruals	-0.86	0.13	-0.99	-0.92	-0.27	-0.64	0.06	0.41	-0.35
	(-3.80)	(0.47)	(-2.83)	(-3.67)	(-0.84)	(-1.63)	(0.23)	(1.22)	(-0.86)

Table 5

Predictive regressions for risk-adjusted returns on long-short strategies

This table reports b_H and b_L in the following regression:

$$r_{i,t} = a + b_H D_{H,t} S_{t-1} + b_L D_{L,t} S_{t-1} + mMKT_t + sSMB_t + hHML_t + \epsilon_{i,t} ,$$

where $D_{H,t}$ ($D_{L,t}$) is the dummy variable set equal to one if the measure of market-wide arbitrage asymmetry at month t is above (below) the median value for the sample period, and zero otherwise. $r_{i,t}$ is the excess return in month t on either the long-, the short-leg, or the long-short portfolio, and S_{t-1} is the Baker and Wurgler sentiment index at month t-1. The non-put-optioned subsample consists of stocks with tradable put options, while the put-optioned subsample contains those without tradable put options. All t-statistics given in parentheses are adjusted based on Newy-West (1987).

		Long-leg		Short-leg		Long-leg		Short-leg	
		b_H	b_L	b_H	b_L	b_H	b_L	b_H	b_L
Panel A. Price-impact measure									
(1)	Analyst disagreement	0.48	0.70	-0.82	-0.61	0.64	0.74	0.06	0.54
		(1.39)	(1.56)	(-2.29)	(-0.76)	(1.80)	(1.60)	(0.10)	(0.68)
(2)	Credit rating	0.17	0.62	-1.80	-2.00	0.18	0.34	-1.76	-0.96
		(0.43)	(1.17)	(-2.58)	(-1.24)	(0.74)	(1.30)	(-1.86)	(-0.75)
(3)	Failure probability	-0.04	0.44	-0.97	-0.80	0.07	0.69	-0.10	-0.53
		(-0.15)	(1.45)	(-1.93)	(-0.70)	(0.19)	(1.68)	(-0.17)	(-0.51)
(4)	Ohlson's O-score	-0.19	0.60	-1.08	-1.26	0.48	0.50	-1.06	-0.16
		(-0.63)	(1.30)	(-2.30)	(-1.52)	(1.01)	(1.18)	(-1.73)	(-0.10)
(5)	Momentum	1.28	-0.16	-2.68	-1.37	1.17	0.10	-1.24	0.64
		(1.89)	(-0.17)	(-3.53)	(-0.74)	(1.83)	(0.08)	(-1.13)	(0.31)
(6)	Return on equity	0.07	-0.21	-1.96	-1.23	0.68	0.40	-1.21	-0.02
		(0.23)	(-0.39)	(-3.49)	(-1.19)	(2.75)	(0.94)	(-2.69)	(-0.02)
(7)	Gross profitability	-0.30	0.59	-1.32	-0.86	-0.12	1.61	-0.46	-0.08
		(-0.74)	(1.13)	(-3.15)	(-1.26)	(-0.37)	(2.96)	(-0.75)	(-0.11)
(8)	Net stock issues	0.64	0.28	-0.21	-0.57	0.39	1.04	0.10	0.18
		(2.44)	(0.64)	(-0.61)	(-0.79)	(1.17)	(3.24)	(0.16)	(0.23)
(9)	Composite stock issues	0.05	-0.37	-0.03	-1.08	-0.35	0.35	0.65	0.42
		(0.16)	(-0.57)	(-0.08)	(-1.77)	(-0.92)	(0.40)	(1.40)	(1.10)
(10)	Investment-to-assets	0.17	-0.19	-0.85	-0.44	0.12	0.66	-0.03	0.88
		(0.45)	(-0.34)	(-2.31)	(-0.61)	(0.30)	(1.26)	(-0.04)	(1.18)
(11)	Asset growth	-1.27	-0.49	-1.00	-0.46	-0.37	1.47	0.13	-0.18
		(-2.36)	(-0.72)	(-2.69)	(-0.43)	(-0.96)	(2.77)	(0.14)	(-0.26)
(12)	Net operating assets	-0.02	0.31	-0.09	-0.53	0.24	0.62	0.24	0.01
		(-0.05)	(0.55)	(-0.27)	(-0.97)	(0.49)	(1.28)	(0.55)	(0.01)
(13)	Total accruals	-1.33	0.12	-0.70	-0.35	-0.99	0.61	0.09	0.58
		(-3.01)	(0.16)	(-1.62)	(-0.41)	(-2.04)	(0.73)	(0.12)	(0.71)
Panel B. Breadth measure									
(1)	Analyst disagreement	1.00	-0.03	-0.51	-1.06	1.15	0.03	-0.16	0.81
		(2.53)	(-0.09)	(-1.25)	(-1.43)	(3.11)	(0.09)	(-0.32)	(0.98)
(2)	Credit rating	0.65	-0.08	-2.44	-1.10	0.34	0.11	-2.73	0.32
		(1.47)	(-0.22)	(-3.02)	(-0.79)	(1.34)	(0.43)	(-3.87)	(0.22)
(3)	Failure probability	0.36	-0.14	-1.12	-0.59	0.33	0.28	-0.76	0.41
		(1.23)	(-0.57)	(-1.78)	(-0.64)	(0.86)	(0.78)	(-1.42)	(0.40)
(4)	Ohlson's O-score	0.11	0.14	-1.13	-1.17	0.63	0.29	-1.45	0.33
		(0.34)	(0.29)	(-2.02)	(-1.82)	(1.30)	(0.72)	(-2.40)	(0.22)
(5)	Momentum	1.16	0.10	-2.70	-1.44	1.00	0.42	-1.72	1.18
		(1.60)	(0.11)	(-3.50)	(-0.80)	(1.46)	(0.35)	(-1.77)	(0.56)
(6)	Return on equity	-0.03	-0.04	-1.80	-1.49	0.69	0.40	-1.27	-0.01
		(-0.09)	(-0.09)	(-2.48)	(-1.89)	(2.53)	(1.09)	(-2.56)	(-0.02)
(7)	Gross profitability	0.17	-0.13	-1.17	-1.10	0.36	0.84	-0.17	-0.49
		(0.41)	(-0.25)	(-2.21)	(-2.04)	(0.94)	(1.38)	(-0.27)	(-0.77)
(8)	Net stock issues	0.78	0.11	-0.34	-0.37	0.53	0.80	0.12	0.14
		(2.79)	(0.26)	(-0.98)	(-0.54)	(1.64)	(2.44)	(0.20)	(0.17)
(9)	Composite stock issues	0.06	-0.36	-0.14	-0.86	-0.53	0.56	0.81	0.21
		(0.18)	(-0.67)	(-0.32)	(-1.26)	(-1.55)	(0.69)	(1.93)	(0.44)
(10)	Investment-to-assets	0.24	-0.27	-0.65	-0.75	0.76	-0.27	0.02	0.75
		(0.52)	(-0.70)	(-1.56)	(-1.14)	(1.95)	(-0.55)	(0.05)	(0.77)
(11)	Asset growth	-0.86	-1.11	-0.62	-1.01	0.25	0.49	-0.06	0.10
		(-1.42)	(-1.83)	(-1.17)	(-1.12)	(0.60)	(0.90)	(-0.07)	(0.12)
(12)	Net operating assets	0.44	-0.35	-0.29	-0.22	0.59	0.11	0.10	0.22
		(1.08)	(-0.66)	(-0.92)	(-0.41)	(1.20)	(0.22)	(0.21)	(0.55)
(13)	Total accruals	-1.04	-0.38	-0.70	-0.37	-0.86	0.33	0.19	0.41
		(1.00)	(-0.03)	(-0.51)	(-1.06)	(1.15)	(0.03)	(-0.16)	(0.81)