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Sophistication, Sentiment, and Misreaction

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Abstract

This study investigates whether the existence or strength of any misreaction in the options market is affected by investor sophistication and investor sentiment. Based on a unique data set of the complete history of all transactions in the Taiwan options market, we find that individual investors exhibit significant misreaction to information and that this misreaction becomes stronger during periods of high investor sentiment. In addition, more active or aggressive individual investors always exhibit misreaction and do not learn from their past mistakes. Our empirical results are robust to alternative measures of investor sentiment and definitions of long- and short-term horizons.

I. Introduction

Numerous behavioral theories (De Long, Shleifer, Summers, and Waldmann (1990), Kumar and Lee (2006), and Lee, Shleifer, and Thaler (1991)) suggest that investors may form incorrect beliefs and thus misevaluate assets. Recent literature has extensively examined these trading anomalies in both the stock markets and the options markets with a particular focus on the pricing impact of investors' behavioral biases.[1] The results have been mixed. For example, both Poteshman (2001) and Stein (1989) find that the impact of volatility shocks is significantly greater for long-term options compared to short-term options,[2] whereas Jiang and Tian (2010) more recently argue that such anomalies are attributable to model

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[1] Shleifer (2000) provides a comprehensive review of the studies on investor misreaction in the stock markets.

[2] As noted by Stein (1989), long-term volatility overreacts to changes in short-term volatility, with both being measured by Black and Scholes's (1973) implied volatility of Standard & Poor's (S&P) 100 index options. Poteshman (2001) provides further tests on misreaction in the options markets based on an examination of implied volatility from S&P 500 index options. The empirical results of that study provide support not only for the long-term overreaction found by Stein but also for short-term underreaction and increasing misreaction.

misspecification rather than market misreaction.[3] Given the mixed empirical results from marketwise observations, we investigate investor misreaction based on the impact of investor sophistication and sentiment, which prior literature shows play important roles in asset pricing and trading.[4]

The motivation for this investigation comes particularly from prior studies that associate heterogeneous beliefs, investor sophistication, investor sentiment, and mispricing in the options markets. Standard models of financial economics usually assume that investors are risk averse, have correct beliefs, and trade in a complete market and thus a representative agent or a unique pricing kernel exists.[5] However, Chabi-Yo, Garcia, and Renault (2008), Hens and Reichlin (2013), and Ziegler (2007) show that this setting is too restrictive and that it is inconsistent with most empirical observations.[6] In other words, a representative agent may not exist, and the pricing kernel is not necessarily unique in a real market, and therefore the asset allocation made by different agents with heterogeneous beliefs corresponds to different pricing kernels. Some beliefs may be incorrect and thus may cause misreaction to information shocks (Polkovnichenko and Zhao (2013), Shefrin (2005), and Ziegler (2007)). This reaction to information shocks in the options market is likely to be different across investor categories grouped by their degree of sophistication.[7] In particular, unsophisticated investors tend to be inexperienced and naïve and thus more likely to exhibit misreaction.

In addition, a number of studies suggest that investor sentiment contains a marketwide component with the potential to influence the prices of many securities.[8] As a result, these studies suggest that sentiment-driven investors can cause prices to deviate from their fundamental value in the options markets (Bollen and Whaley (2004), Figlewski (1989), Green and Figlewski (1999), Han (2008), Lemmon and Ni (2010), and Ofek, Richardson, and Whitelaw (2004)). In particular, Han (2008) and Lemmon and Ni (2010) argue that the changes in investor sentiment can help to explain the time variation of the implied volatility function

[3]Based on their reexamination of the pattern of anomalies through the implementation of a model-free approach, Jiang and Tian (2010) find no evidence of market misreaction. Chang, Hsieh, Tang, and Wang (2013) also support this finding in the Taiwan options market.

[4]Studies on the impact of unsophisticated investors include Coval and Shumway (2005), Daniel and Titman (1997), Daniel, Hershleifer, and Subrahmanyam (1998), De Bondt and Thaler (1985), Hong and Stein (1999), Lakonishok, Shleifer, and Vishny (1994), Shleifer (2000), and Shleifer and Vishny (1997). Recent studies addressing the sentiment effect include Brown and Cliff (2004), (2005), Kumar and Lee (2006), Lemmon and Portniaguina (2006), Tetlock (2007), and Yu and Yuan (2011).

[5]Classic papers include Harrison and Kreps (1979) and Harrison and Pliska (1981).

[6]Chabi-Yo et al. (2008), Hens and Reichlin (2013), and Ziegler (2007), respectively, use belief-dependent utilities, incomplete markets, and heterogeneous beliefs to explain the pricing kernel puzzle, which is usually estimated jointly from historical returns and options prices.

[7]Prior empirical studies often distinguish investors by their level of sophistication, which corresponds to their informed levels. Mahani and Poteshman (2008) find that unsophisticated investors in the options market overreact to past news on the underlying stocks based on the mistaken belief that mispriced stock prices tend to move even further away from their fundamental values when the scheduled news is released. In addition, several studies (Barber, Lee, Liu, and Odean (2009), Chang, Hsieh, and Lai (2009), and Mahani and Poteshman (2008)) investigate the trading performance of investors with different degrees of sophistication.

[8]In particular, Baker and Wurgler (2006) argue that the marketwide sentiment is associated with cross-sectional return differences of stocks with different characteristics.

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and the risk-neutral skew constructed from equity options. In addition, Chung, Hung, and Yeh (2012), Stambaugh, Yu, and Yuan (2012), and Yu and Yuan (2011) find that the existence or strength of several financial anomalies hinges on investor sentiment.[9] Therefore, investor sentiment may affect the formation of investors' beliefs or pricing kernels, which essentially reflect investors' reaction to information shocks. In particular, investors trade more often and more aggressively and are more likely to exhibit misreaction during high-sentiment periods.

To obtain more insights on the issue of investor misreaction given the two potential factors of investor sophistication and sentiment, we conduct a comprehensive analysis using a unique and complete data set that contains the details of all transactions and orders, including the identity of each investor, for the period from 2002 to 2008 in the Taiwan options market. This comprehensive data set allows us to explore the transactions not only from a marketwise perspective but also from the perspectives of various categories of investors, including domestic institutional investors, foreign institutional investors, individual investors, and market makers. As the Taiwan options market is one of the most actively traded markets in the world, our findings can be fairly generalized to the other markets.[10]

Following the previous studies that motivate our investigation, we relax the assumption on uniqueness of the pricing kernel for our empirical analysis.[11] Consistent with the prior studies (Chang et al. (2013), Jiang and Tian (2010)) that primarily involve an exploration of the variations in model-free option implied volatility, which to some extent reflects the expectations of investors on future volatility,[12] our empirical results on the marketwise transactions provide no significant evidence of the existence of either market misreaction or a sentiment effect in the options market. However, when we assume the existence of a pricing kernel for each subset of investors and then explore the transactions of alternative types of investors using two alternative sentiment indices compiled following the approach of Baker and Wurgler (2006), we find that individual investors exhibit significant misreaction to information and that such misreaction becomes more pronounced during periods of high investor sentiment.[13] Although domestic

[9] Yu and Yuan (2011) find that the positive mean–variance relation exists in low-sentiment periods only, whereas Chung et al. (2012) report that the return predictability of sentiment is more pronounced in the expansion state only. In addition, Stambaugh et al. (2012) explore a broad set of anomalies in cross-sectional stock returns and find that these anomalies are stronger following high levels of sentiment.

[10] In terms of both the number of traded contracts and the notional turnover in 2012, Taiwan Futures Exchange is one of the top 10 exchanges for the trading of equity derivatives. In particular, it is ranked ninth by the number of traded contracts of index futures and options.

[11] The only assumption that we need to make is the existence of a pricing kernel for each subset of investors. Because the marketwide pricing kernel for all investors is simply aggregating over the marginal pricing kernels based on transactions of subsets of investors, we do not need to assume uniqueness of the pricing kernel.

[12] If the expectations of investors fully and rationally reflect the available information, the changes in implied volatility should simply incorporate the relevant information without producing any anomalous patterns.

[13] The three sentiment proxies are described fully in Section II.B.

institutional investors are usually characterized as sophisticated investors, their patterns of misreaction can sometimes be quite similar to those of individual investors.[14]

To extend our study, we investigate whether individual investors who trade more actively or aggressively display any difference in their patterns of misreaction. Kuo and Lin (2013) show that investors who trade more actively and aggressively are not only overconfident of the accuracy of their information but are also biased in their interpretation of the information. Therefore, this group of individual investors should exhibit more severe misreaction compared to less active or aggressive individual investors. We find that more active or aggressive individual investors such as day traders and those with high trading volume and frequency always misreact to information shocks and that such misreaction becomes stronger during high-sentiment periods, whereas individuals that are not classified as more active or aggressive usually exhibit misreaction only during high-sentiment periods. We further investigate whether these groups of more active or aggressive individual investors learn from their past mistakes and find that their previous prediction error magnifies the degree of misreaction. In other words, overconfidence rather than information primarily drives activeness and aggressiveness.

In sum, we find no misreaction for the marketwise observations regardless of the level of investor sentiment, which is consistent with Jiang and Tian (2010). However, we investigate the trading performance of unsophisticated investors and find that their poor performance is due to some behavioral biases, namely, sentiment-based trading and overconfidence, which is in line with many prior studies, including Barber and Odean (1999), (2000), (2001), Barber et al. (2009), Chang et al. (2009), Jordan and Diltz (2003), Kuo and Lin (2013), Mahani and Poteshman (2008), and Odean (1999). In addition, our results confirm the existence of heterogeneous beliefs or pricing kernels, some of which may be incorrect (Chabi-Yo et al. (2008), De Long et al. (1990), Kumar and Lee (2006), Lee et al. (1991), and Ziegler (2007)). Our empirical results are robust to alternative sentiment measures and definitions of duration.

This study contributes to the extant literature by considering the potential reasons for the contradictory findings reported in the prior studies on market misreaction. We provide evidence on the existence of relationships among market misreaction, investor sophistication, and investor sentiment.

The remainder of this paper is organized as follows: Section II provides a discussion of the data used for the empirical analysis. Section III develops our hypotheses and presents our empirical specifications. Section IV presents the main findings and empirical results. Section V provides an investigation of the robustness of the results to alternative sentiment measures and definitions of maturity. Section VI offers conclusions drawn from this study.

[14]Our data reveal that the average holding period for domestic institutional investors is much shorter than that for foreign institutional investors. Based on the principle of first-in/first-out, the average holding period for domestic (foreign) institutional investors is about 6 (17) days. Thus, in the Taiwan options market, the trading patterns of domestic institutional investors appear to be more akin to those of individual investors than those of foreign institutional investors.

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II. Data and Method

A. Options Data

The data set provides a comprehensive record of all option transactions on the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) for the period from Jan. 2, 2002 to Dec. 31, 2008.[15] Because our options data set covers a sufficiently long period, we are able to select periods with obvious upward (bull market) and downward (bear market) trends based on monthly TAIEX levels. We focus on two discernible bull market periods (May 2003–Mar. 2004 and Sept. 2004–Nov. 2007) and three bear market periods (Apr. 2002–Oct. 2002, Mar. 2004–Aug. 2004, and Dec. 2007–Dec. 2008). The data set is obtained from the Taiwan Futures Exchange (TAIFEX), where these options are traded, with each record of the data set providing the identification and class of the trader, the type of option (call/put), the characteristics of the option (strike price and time to expiration), trading direction (buy/sell), transaction price, and volume (number of contracts). Because we can explicitly identify the class of trader for each trade, we are able to investigate market reaction not only from a marketwise perspective but also from the perspectives of four types of traders: domestic institutional investors, foreign institutional investors, individual investors, and market makers.

We also apply exclusion rules similar to those adopted in many prior studies to discard options with illiquidity, extreme characteristics, or data errors. Specifically, only those option contracts that meet each of the following criteria are included in our study sample: C1) a time to expiration period of greater than or equal to 6 calendar days and less than or equal to 7 months;[16] C2) a bid or ask price of greater than or equal to 0.5 index points;[17] C3) Black–Scholes (1973) implied volatility of greater than 0 and less than or equal to 0.7; and C4) observations must relate to either at-the-money (ATM) or out-of-the-money (OTM) options.[18] Table 1 reports the sample statistics on all observations meeting all four conditions. To form the implied volatility curve for the model-free approach,[19] OTM puts are transposed to in-the-money (ITM) calls; thus, the statistics in Table 1 refer to call options only. The total number of observations for the full sample period is 65,876; the number of observations for the bull and bear market regimes is 41,646 and 22,017, respectively.

We calculate Black–Scholes (1973) implied volatility from the call options in our final sample. The risk-free rate is set at the average deposit rate for the five major banks in Taiwan (the rate offered by the Central Bank of Taiwan). We report

[15] Our sample period is much longer than that Chang et al. (2013), which ends in 2006.

[16] Options contracts with maturity periods outside this range are usually found to be illiquid.

[17] One index point for TAIEX options is equal to $200 new Taiwan dollar (NTD) (about $6.7 U.S. dollar (USD)). We observe that the premium for illiquid options is always less than one-half an index point, which thereby represents only $100 NTD.

[18] Although in theory the information content of calls and puts with the same strike price should be identical, they typically differ empirically. Because OTM contracts are invariably more liquid than in-the-money contracts, only OTM and ATM contracts are included in our empirical data set; thus, no two contracts in our data set have the same maturity and strike prices.

[19] A description of the model-free approach is provided in Section III.

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TABLE 1

Summary Statistics of Options Data

Table 1 presents the summary statistics for TAIEX options filtered by four criteria: C1) time to expiration is greater than or equal to 6 calendar days and less than or equal to 7 months; C2) the bid or ask price is greater than or equal to 0.5 index points; C3) Black–Scholes (1973) implied volatility is greater than 0 and less than or equal to 0.7; and C4) the options are either at the money or out of the money. The summary statistics refer to call options only; in-the-money call options are transferred from out-of-the-money put options using put–call parity. BS_VOL refers to Black–Scholes implied volatility; *T* is time to maturity (in years); *X* is the strike price for the corresponding call option; and *r* is the 1-month average deposit rate of the five major banks in Taiwan, as offered by the Central Bank of Taiwan. MONEYNESS is defined as the strike price over the futures price. The full sample period runs from Jan. 2, 2002 to Dec. 31, 2008. The bull markets include the periods from May 2003 to Mar. 2004 and Sept. 2004 to Nov. 2007, and the bear markets include the periods from Apr. 2002 to Oct. 2002, Mar. 2004 to Aug. 2004, and Dec. 2007 to the end of 2008. The summary statistics are reported for both marketwise transactions and those across four categories of investors (domestic institutional, foreign institutional, individual investors, and market makers).

	Full Sample			Domestic Institutional Investors			Foreign Institutional Investors			Individual Investors			Market Makers		
Variables	No. of Obs.	Mean	Standard Deviation	No. of Obs.	Mean	Standard Deviation	No. of Obs.	Mean	Standard Deviation	No. of Obs.	Mean	Standard Deviation	No. of Obs.	Mean	Standard Deviation
Panel A. Whole Market															
Option prices	65,876	364	411	18,513	255	280	11,343	320	327	54,691	343	394	49,595	338	383
BS_VOL		0.205	0.079		0.207	0.083		0.234	0.093		0.204	0.079		0.205	0.081
T		0.208	0.171		0.109	0.085		0.173	0.142		0.194	0.162		0.175	0.146
X		6,776	1,499		6,709	1,401		6,965	1,543		6,758	1,482		6,787	1,470
r		0.020	0.004		0.019	0.004		0.021	0.005		0.020	0.004		0.020	0.004
MONEYNESS		1.000	0.112		1.001	0.071		1.005	0.082		1.007	0.106		1.004	0.100
Panel B. Bull Market															
Option prices	41,646	394	418	12,007	249	275	5,392	308	320	34,967	367	397	31,561	359	389
BS_VOL		0.167	0.053		0.167	0.052		0.175	0.056		0.166	0.053		0.166	0.053
T		0.224	0.180		0.114	0.091		0.173	0.147		0.211	0.173		0.190	0.157
X		6,788	1,335		6,788	1,260		7,075	1,362		6,780	1,325		6,839	1,302
r		0.019	0.003		0.019	0.003		0.019	0.004		0.019	0.003		0.019	0.003
MONEYNESS		0.984	0.089		0.992	0.059		0.990	0.060		0.986	0.085		0.986	0.081
Panel C. Bear Market															
Option prices	22,017	336	414	6,105	279	300	5,867	337	327	17,973	362	406	16,281	318	384
BS_VOL		0.271	0.077		0.281	0.081		0.289	0.087		0.271	0.076		0.274	0.079
T		0.192	0.159		0.102	0.083		0.177	0.139		0.174	0.147		0.154	0.125
X		7,027	1,641		6,790	1,521		6,949	1,634		6,992	1,615		6,974	1,623
r		0.022	0.005		0.021	0.005		0.023	0.005		0.022	0.005		0.022	0.005
MONEYNESS		1.048	0.138		1.016	0.089		1.020	0.097		1.044	0.131		1.038	0.123

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the summary statistics for the marketwise transactions and for the transactions across the four different types of investors. Based on the number of observations from the alternative types of investors, individual investors and market makers are clearly the major participants in the TAIEX options market.

B. Investor Sentiment Proxies

We follow several prior studies to select investor sentiment proxies, which we subsequently modify based on similar, available information for the Taiwan market. In particular, we follow Baker and Wurgler (2006) to form a composite sentiment index (BW6) with six measures of investor sentiment: the net purchases of mutual funds (FUND_FLOW), the Taiwan Stock Exchange (TWSE) share turnover (TURN), the number of initial public offerings (NIPO), the average first-day returns of initial public offerings (RIPO), the equity share in new issues (S), and the dividend premium (DP).[20] We measure the sentiment proxies monthly from Jan. 2001 to Dec. 2008. We obtain the monthly data on these sentiment proxies from *Taiwan Economic Journal* (TEJ).[21]

To remove the business cycle effect, Baker and Wurgler (2006) first regress each of the six raw proxies on a set of macroeconomics variables and then use the residuals to compile the sentiment index as the first principal component of the six series of residuals. We use the growth in the industrial production index and the growth in consumer goods and services surveyed by Taiwan's Directorate General of Budget, Accounting and Statistics, Executive Yuan, and a dummy variable for recessions surveyed by Taiwan's Council for Economic Planning and Development to make the six sentiment proxies orthogonalized to business cycle.[22] With the orthogonalized proxies, we construct the sentiment index as

$$\begin{aligned}(1)\quad \mathrm{BW6}_t \;=\;& 0.329\,\mathrm{FUND_FLOW}_t + 0.251\,\mathrm{TURN}_{t-1} \\ &+ 0.450\,\mathrm{NIPO}_t - 0.188\,\mathrm{RIPO}_{t-1} + 0.333\,S_t - 0.172\,\mathrm{DP}_{t-1},\end{aligned}$$

where the first principal component explains 54% of the sample variance of the orthogonalized variables.

In addition to the six sentiment proxies suggested by Baker and Wurgler (2006) and Brown and Cliff (2004), some proxies similar to the bull–bear spread

[20] Many prior studies (e.g., Chung et al. (2012), Stambaugh et al. (2012), and Yu and Yuan (2011)) use Baker and Wurgler's (2006) sentiment index. Because no closed-end fund is issued in Taiwan after Jan. 2002, we are unable to compile the closed-end fund discount suggested by Baker and Wurgler. Therefore, we replace it with a similar measure, the net purchases of mutual funds, suggested by Brown and Cliff (2004).

[21] Following Baker and Wurgler (2006) to avoid the exponential and positive trend of share turnover over our sample period, we define TURN as the natural log of the raw turnover ratio, detrended by the 5-year moving average.

[22] Taiwan's National Statistics publishes the industrial production index and growth in consumer goods and services on its Web site (http://eng.stat.gov.tw/). The dummy variable of recessions is determined from the business indicator published by the National Development Council, ROC. We define recessions as the time points when the business indicator reaches the peak of a business cycle and begins to decline.

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used in Brown and Cliff (2004), (2005), Han (2008), and the Consumer Sentiment Index carried out by the University of Michigan are also quite frequently used as proxies to gauge the marketwide sentiment in the Taiwan market. Therefore, we include three additional sentiment proxies to compile an alternative sentiment index. The first proxy, symbolized as $\text{BUY_SELL}_{\text{TAIEX}}$, is defined as the bullish minus bearish proportions of institutional investors in the TWSE.[23] The second proxy, symbolized as $\text{LONG_SHORT}_{\text{TAIFEX}}$, is initially calculated as the number of long contracts minus the number of short contracts in TAIEX futures traded by institutional investors and then scaled by the month-end open interest for TAIEX futures.[24] The third proxy, symbolized by $\text{CCI}_{\text{SURVEY}}$, is the Consumer Confidence Index (CCI) survey undertaken by the Research Center for Taiwan Economic Development at the National Central University to derive perceptions of individual investors on current and future financial conditions.[25] Following the same procedure used to construct the BW6, we obtain an alternative sentiment index (BW9) as the first principal component of the nine orthogonalized sentiment proxies. In particular, with the orthogonalized proxies, this sentiment index is constructed as

$$
\begin{aligned}
(2) \qquad \text{BW9}_t \;=\; & 0.203\,\text{FUND_FLOW}_t + 0.189\,\text{TURN}_{t-1} + 0.315\,\text{NIPO}_t \\
& - 0.199\,\text{RIPO}_{t-1} + 0.278\,S_t - 0.121\,\text{DP}_{t-1} \\
& - 0.044\,\text{BUY_SELL}_{\text{TAIEX}} - 0.182\,\text{LONG_SHORT}_{\text{TAIFEX}} \\
& + 0.302\,\text{CCI}_{\text{SURVEY}},
\end{aligned}
$$

where the first principal component explains 62% of the sample variance of the orthogonalized variables.

Table 2 reports the summary statistics and the correlation metrics of the nine sentiment proxies. These sentiment proxies are quite differently distributed and not necessary strongly correlated regardless of whether they are orthogonalized

[23]The TWSE has three major institutional investors, all of which are foreign investors: mainland area investors, securities investment trust companies, and dealers. The TWSE provides a monthly survey of the trading details of these foreign institutional investors on its Web site (http://www.twse.com.tw/en/).

[24]The trading statistics for the futures market, which are presented at the end of each calendar month, provide the total number of long and short positions and total open interest for individual investors, securities dealers, securities investment trust companies, foreign investors, futures trust funds, other institutional investors, and proprietary traders. The complete statistics are available from the TAIFEX Web site (http://www.taifex.com.tw/eng/eng_home.htm).

[25]The method of calculation for the CCI in Taiwan is similar to that used for the calculation of the Consumer Sentiment Index carried out by the University of Michigan. Consumers are asked six questions, each of which reflects their expectations of economic conditions in the coming 6 months. Models are then used to calculate six subindices, and the calculation of the average of these six subindices ultimately creates the overall index. The survey questionnaire covers six economic conditions: whether the price level will rise or fall, whether family economic conditions will become better or worse, whether employment opportunities will increase or decrease, whether the business climate will become better or worse, whether it is a good or bad time to buy stocks, and whether it is a good or bad time to buy durable goods. Full details on the models used for these six subindices are available at the Research Center for Taiwan Economic Development Web site (http://rcted.ncu.edu.tw/e_intro.phtml).

TABLE 2

Summary Statistics of Investor Sentiment Proxies

The left-hand side (columns 1–4) of Table 2 presents the summary statistics and the correlation matrix of the raw sentiment proxies, including the six sentiment proxies suggested by Baker and Wurgler (2006) and Brown and Cliff (2004) and three additional sentiment proxies frequently used in the Taiwan market. FUND_FLOW is the net purchases of mutual funds. TURN is the TWSE share turnover. NIPO is the number of initial public offerings. RIPO is the average first-day returns of initial public offerings. *S* is equity share in new issues. DP is the dividend premium. BUY_SELL_{TAIEX} is defined as the bullish minus bearish proportions of institutional investors in the TWSE. $LONG_SHORT_{TAIFEX}$ is calculated as the number of long contracts minus the number of short contracts in TAIEX futures traded by institutional investors and then scaled by the month-end open interest for TAIEX futures. CCI_{SURVEY} is the Consumer Confidence Index survey undertaken by the Research Center for Taiwan Economic Development at the National Central University. The right-hand side (columns 5–13) presents the summary statistics and correlation matrix of the orthogonalized proxies, which are the residuals from regressions on the macroeconomic conditions including the growth in industrial production, the growth in consumption goods and services, and a dummy variable of recessions. All data are collected at the monthly frequency for the period from Jan. 2002 to Dec. 2008.

	Summary Statistics				Correlations with Other Sentiment Proxies								
	Mean	Standard Deviation	Min	Max	FUND_FLOW	TURN	NIPO	RIPO	*S*	DP	BUY_SELL_{TAIEX}	$LONG_SHORT_{TAIFEX}$	CCI_{SURVEY}
Panel A. Raw Data													
BW6 Components													
FUND_FLOW	27.54	7.35	7.35	47.28	1.00	0.31	0.36	–0.04	0.21	–0.00	0.07	–0.03	0.29
TURN	–1.04	0.43	–1.72	0.17		1.00	0.27	0.24	0.18	–0.09	–0.26	–0.19	0.35
NIPO	6.22	5.28	1.00	23.00			1.00	–0.25	0.50	0.01	–0.01	–0.06	0.41
RIPO	–0.70	0.59	–1.07	3.29				1.00	–0.09	0.19	–0.16	0.11	–0.38
S	0.28	0.24	0.00	0.83					1.00	0.14	0.03	–0.15	0.48
DP	–0.87	0.40	–2.81	–0.21						1.00	0.22	0.18	0.13
Additional 3 Components													
BUY_SELL_{TAIEX}	0.03	0.09	–0.15	0.22							1.00	0.41	0.29
$LONG_SHORT_{TAIFEX}$	0.02	0.02	–0.06	0.07								1.00	–0.04
CCI_{SURVEY}	–0.02	0.10	–0.33	0.17									1.00
Panel B. Controlling for Macroeconomic Conditions													
BW6 Components													
FUND_FLOW	0.00	6.56	–9.57	16.98	1.00	0.22	0.32	–0.08	0.11	–0.08	0.05	–0.07	0.17
TURN	0.00	0.37	–0.83	1.02		1.00	0.23	0.24	0.10	–0.21	–0.32	–0.28	0.18
NIPO	0.00	4.93	–6.65	15.92			1.00	–0.25	0.42	–0.07	–0.08	–0.09	0.33
RIPO	0.00	0.58	–0.39	3.91				1.00	–0.12	0.18	–0.16	0.13	–0.44
S	0.00	0.38	–1.76	0.82					1.00	0.03	0.03	–0.15	0.44
DP	0.00	0.22	–0.42	0.51						1.00	0.21	0.19	–0.00
Additional 3 Components													
BUY_SELL_{TAIEX}	0.00	0.08	–0.17	0.19							1.00	0.41	0.26
$LONG_SHORT_{TAIFEX}$	0.00	0.02	–0.06	0.07								1.00	–0.09
CCI_{SURVEY}	0.00	0.09	–0.25	0.17									1.00

to the business cycle. Therefore, we are very likely to reach different conclusions if we perform our empirical analysis separately based on these different sentiment proxies. By following Baker and Wurgler (2006) to identify the first principal component from these sentiment proxies, we can construct a rigorous investor sentiment index with those variables available in the Taiwan market.

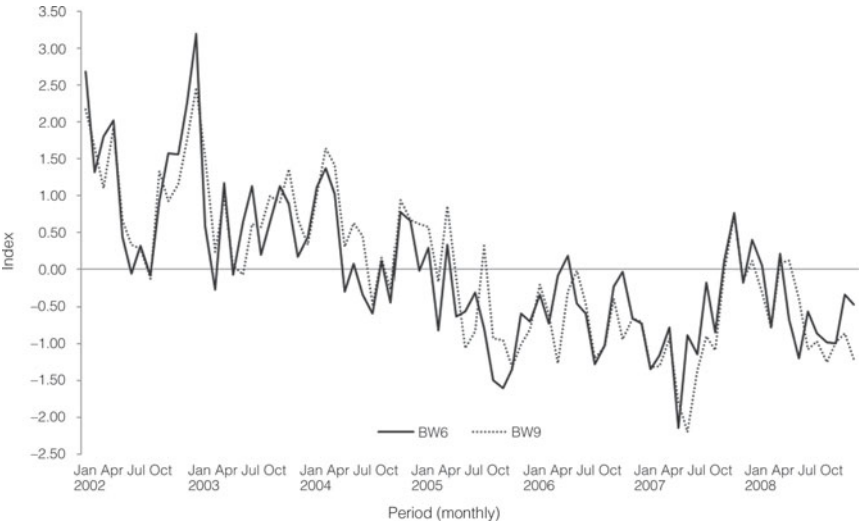
Figure 1 illustrates the monthly time series of the two investor sentiment indices, BW6 and BW9, from Jan. 2002 to Dec. 2008. The figure shows that the indices have a large positive correlation, with a correlation coefficient as high as 0.94. When employing any of the sentiment indices for our empirical analysis, we define the observation as a high- (low-) sentiment month if the index is positive (negative) during the previous month because all observations are standardized to a mean of 0.

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FIGURE 1

Time Series of Investor Sentiment Indices

Figure 1 shows the monthly time series of the investor sentiment indices from Jan. 2002 to Dec. 2008. The solid line indicates the time series of the BW6 sentiment index, which is constructed by the first principal component of the six orthogonalized sentiment proxies suggested by Baker and Wurgler (2006) and Brown and Cliff (2004). The dashed line indicates the time series of the BW9 sentiment index, which is measured by the first principal component of the six orthogonalized sentiment proxies used to construct BW6 and three additional orthogonalized sentiment proxies of $\text{BUY_SELL}_{\text{TAIEX}}$, $\text{LONG_SHORT}_{\text{TAIFEX}}$, and $\text{CCI}_{\text{SURVEY}}$.



C. Model-Free Implied Volatility

We follow the methods of Jiang and Tian (2010) and Poteshman (2001) to identify market misreaction based on observations of implied volatility extracted from market prices. Because a model-free approach is, by definition, free of model misspecification, we follow the model-free framework proposed in Jiang and Tian (2005), (2010) to estimate the implied volatility levels from options with two different maturity periods.

The annualized forward-integrated variance is defined as

$$v(t, T_1, T_2) \equiv \frac{1}{T_2 - T_1} \mathrm{E}_t \left[\int_{T_1}^{T_2} \left(\frac{dS_\tau}{S_\tau} \right)^2 \right], \tag{3}$$

where $t \leq T_1 \leq T_2$ and $v(t, T_1, T_2)$ measures the integrated expected variance over the period from T_1 to T_2 on the information at time t. Therefore, equation (3) indicates a forward-integrated variance over a future time period [T_1 to T_2] measured at time t. For the special case when $t = T_1$, equation (3) degenerates to the general form of $v(t, T) \equiv v(t, t, T)$, which is referred to as the spot variance.

Based on the approach proposed by Britten-Jones and Neuberger (2000) for the extraction of forward variance from the market prices of options with different

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maturity periods and across different strike prices, the integrated variance between the two maturity dates is given as

$$(4)\quad \mathrm{E}_t\left[\int_{T_1}^{T_2}\left(\frac{dS_\tau}{S_\tau}\right)^2\right] = 2\int_0^\infty \frac{C_t\left[T_2, \frac{K}{B(t,T_2)}\right] - C_t\left[T_1, \frac{K}{B(t,T_1)}\right]}{K^2}dK,$$

where $t \le T_1 \le T_2$; $B(t,T)$ is the price of a zero-coupon bond at time t that pays \$1 at time T and $C_t(T,K)$ is the price of a call option at time t, with strike price K, maturing at time T.

The annualized forward variance implied by option prices is calculated by combining equations (3) and (4):

$$(5)\quad v(t,T_1,T_2) \equiv \frac{2}{T_2-T_1}\int_0^\infty \frac{C_t\left[T_2, \frac{K}{B(t,T_2)}\right] - C_t\left[T_1, \frac{K}{B(t,T_1)}\right]}{K^2}dK.$$

The right-hand side of equation (5) is the model-free forward variance, and its square root is the model-free forward volatility. Similarly, when $T_1 = t$ and $T_2 = t$, the model-free spot variance is a special case of the model-free forward variance that is reformulated as

$$(6)\quad v(t,t,T) \equiv \frac{2}{T-t}\int_0^\infty \frac{C_t\left[T, \frac{K}{B(t,T)}\right] - \max\{0, S_t - K\}}{K^2}dK.$$

Theoretically, to estimate the model-free forward variance defined in equation (5) effectively, our sample of options must have continuous strike prices of $0 \to \infty$; however, the options that are observed in the market cover only a finite range of discrete strike prices. We therefore follow Jiang and Tian (2005), (2007) to reduce both truncation and discretization errors, by first using the natural cubic splines to fit a smooth function of the Black–Scholes (1973) implied volatility surface between the maximum and minimum available strike prices. We then extrapolate option prices beyond the maximum and minimum available strike prices as the Black–Scholes implied volatility with the closest available strike price.

Once the implied volatility surface has been obtained, we can use the numerical integration method to calculate the model-free forward variance based on equation (5).[26] To obtain alternative definitions of the long term, we use two maturity groups (consisting of the second and third nearby maturity periods) to represent T_2 for the calculation of forward variance. Specifically, the T_2 maturity group includes the maturity periods of the second nearby month options (30–60 days), and the T_3 maturity group includes the maturity periods of the

[26] Jiang and Tian (2005), (2007) provide details of the numerical methodology.

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third nearby month options (60–90 days).[27] Consequently, our empirical analysis involves the use of three groups of spot variance and two groups of forward variance.

Table 3 provides the summary statistics of model-free implied variances. Columns 1–6 report the descriptive statistics of the spot variance extracted from the TAIEX options using a model-free approach, formulated as equation (6). The spot variance of shorter maturity options is, in general, greater than that of longer maturity options; the average spot variance levels for the first three nearby options are 7.29%, 6.59%, and 5.73%. The spot variance extracted from the high-sentiment-period subsample is not obviously different from that extracted from the low-sentiment-period subsample; the mean value of the spot variance from the first nearby options for the high- (low-) sentiment period is 7.66% (6.96%).

TABLE 3

Summary Statistics of Model-Free Implied Variances

Table 3 presents the descriptive statistics of the spot and forward implied variances extracted from the market prices of TAIEX options using a model-free approach, with the sample period running from Jan. 2, 2002 to Dec. 15, 2008. The first, second, and third maturity groups (T_1, T_2, and T_3, respectively) in the spot variance comprise options with the respective first, second, and third nearby maturity months. The results for the whole sample are reported for high- and low-sentiment periods according to the BW9 index for the previous month, which is the sentiment index constructed by the approach of Baker and Wurgler (2006). The corresponding two groups of forward variance are generated based upon the three spot variance groups. We also report the summary statistics of the model-free implied spot and forward variances calculated from the transactions of the four types of investors.

	Spot Variance						Forward Variance			
	$(0, T_1)$		$(0, T_2)$		$(0, T_3)$		(T_1, T_2)		(T_1, T_3)	
Variables	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Full sample	0.0729	0.0610	0.0659	0.0536	0.0573	0.0435	0.0745	0.0610	0.0640	0.0542
High-sentiment period	0.0766	0.0434	0.0602	0.0470	0.0335	0.0420	0.0461	0.0716	0.0180	0.0566
Low-sentiment period	0.0696	0.0709	0.0580	0.0596	0.0375	0.6456	0.0491	0.0637	0.0258	0.0551
Domestic institutional investors	0.0694	0.0627	0.0535	0.0461	0.0515	0.0414	0.0730	0.0636	0.0420	0.0000
Foreign institutional investors	0.0850	0.0745	0.0893	0.0685	0.0804	0.0427	0.0880	0.0747	0.0926	0.0615
Individual investors	0.0725	0.0609	0.0644	0.0538	0.0530	0.0364	0.0743	0.0609	0.0629	0.0547
Market makers	0.0723	0.0608	0.0636	0.0532	0.0508	0.0402	0.0740	0.0609	0.0586	0.0593

Table 3 also provides details of the spot variance extracted from the transactions of the various classes of investors. The properties of the spot variance extracted from the four types of investors are, in general, similar. However, the spot variance extracted from the transactions of foreign institutional investors is slightly higher than that estimated from the transactions of the other types of investors.

Columns 7–10 of Table 3 provide the summary statistics of the two forward variance groups. The forward variance of short-maturity options is greater than that of long-maturity options. The mean value for the (T_1, T_2) group is 7.45%, and the mean value for the (T_1, T_3) group is 6.40%. The forward variance estimated from the high-sentiment-period subsample is slightly smaller than that estimated

[27] Although the standard option contracts provided by the TAIFEX contain five types of maturity dates, only the first three nearby month contracts are actively traded; the share of total trading volume for the fourth nearby month contracts is less than 5%. Therefore, based on insufficient data on longer maturity periods, we focus only on two alternative forward maturity dates.

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from the low-sentiment-period subsample; the mean value for the high- (low-) sentiment-period subsample is 4.61%, (4.91%) for the (T_1, T_2) maturity group.

Furthermore, the forward variance extracted from the transactions of foreign institutional investors is noticeably greater than the forward variance extracted from other types of investors. Specifically, the mean value of the forward variance calculated from the transactions of foreign institutional investors is 8.80% for the (T_1, T_2) maturity group and as high as 9.26% for the (T_1, T_3) maturity group.

III. Hypotheses and Empirical Specifications

A. Hypothesis Development

Some prior studies provide evidence of some forms of investor misreaction in the options markets, such as short-horizon underreaction and long-horizon overreaction (e.g., Chao, Li, and Yu (2005), Mahani and Poteshman (2008), Poteshman (2001), and Stein (1989)).[28] However, based on their adoption of a model-free approach, Jiang and Tian (2010) argue that these anomalous patterns are essentially attributable to model misspecification rather than market misreaction. We investigate the possible reasons for these mixed findings by examining whether investor sophistication and investor sentiment affect the patterns of misreaction identified in prior empirical studies.

Because different subsets of investors may have heterogeneous beliefs and thus form distinct pricing kernels, the ways in which investors react to information may be dependent on their level of sophistication. In fact, numerous studies report that less-sophisticated investors (i.e., individual traders) are more likely to be irrational and trade with incorrect beliefs or pricing kernels compared to sophisticated investors (i.e., institutional investors) and that they therefore tend to misreact to information (see, e.g., Barber et al. (2009), Chang et al. (2009), Lakonishok, Lee, Pearson, and Poteshman (2007), Lemmon and Ni (2010), Mahani and Poteshman (2008), and Pan and Poteshman (2006)). In particular, Chang et al. (2009) and Mahani and Poteshman investigate the trading performance of investors with different degrees of sophistication and find that unsophisticated investors in the options market overreact to past news on the underlying stocks based on mistaken beliefs. Therefore, our first hypothesis is stated as

Hypothesis 1. Individual investors are more likely than other categories of investors to misreact to information.

We also argue that investor sentiment affects investor misreaction. Prior research shows the market price of an asset may deviate from its fundamental value for an unexpectedly long period due to the misreaction of investors to new information (De Long et al. (1990)).[29] In fact, empirical evidence shows that investor sentiment affects asset prices in both the stock (Baker and Wurgler

[28] Stein (1989) demonstrates long-horizon overreaction in the options markets, and both Chao et al. (2005) and Poteshman (2001) find short-horizon underreaction and long-horizon overreaction in the options markets. Mahani and Poteshman (2008) note that unsophisticated options investors overreact to news announced on the stock markets.

[29] De Long et al. (1990) find that if the stocks of a firm are predominantly held by noise traders, the prices may deviate from their fundamental value for extended periods of time.

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(2006), (2007), Brown and Cliff (2005), Coval and Shumway (2005), Kumar and Lee (2006), Kurov (2010), Lemmon and Portniaguina (2006), Stambaugh et al. (2012), Tetlock (2007), and Yu and Yuan (2011)) and options markets (Han (2008), Lemmon and Ni (2010)). Therefore, if investor sentiment is a potential driver of irrational behavior, misreaction in the market is likely be more readily observed during periods of high sentiment. The optimistic atmosphere that prevails during such periods tends to result in irrational investors overreacting to information with incorrect beliefs or pricing kernels, thereby leading to overpricing of the associated assets. Conversely, mispricing is less significant during periods of low investor sentiment. Consequently, the second of our hypotheses is stated as follows:

Hypothesis 2. Market misreaction is more likely to exist during periods of high investor sentiment.

As suggested by the empirical results of several prior studies (e.g., Kumar and Lee (2006), Lee et al. (1991)), individual traders are the most likely candidates for sentiment-driven investors and subject to various types of cognitive biases.[30] Therefore, we state the joint validity of Hypotheses 1 and 2 in our third hypothesis:

Hypothesis 3. Misreaction to information by individual investors will be more significant during periods of high investor sentiment.

In other words, the trading behavior of less-sophisticated investors is more likely to be affected by sentiment biases, with such behavioral biases potentially being more significant during periods of high sentiment.

B. Empirical Specification

To avoid model misspecification, we follow Jiang and Tian (2010) and adopt a model-free approach for the estimation of implied volatility from the market prices of options to gauge the ways in which investors react to new information. Jiang and Tian (2010) investigate whether long-horizon implied volatility overreacts to changes in short-horizon implied volatility using the following ordinary least squares regression:

$$\Delta v_t(T_1, T_2) = \alpha + \beta v(t, T_1) + \varepsilon_t, \tag{7}$$

where

$$\Delta v_t(T_1, T_2) = v(T_1, T_2) - \hat{v}(t\,; T_1, T_2), \tag{8}$$

where $v(t, T_1)$ is the spot variance implied from option prices, as defined in Section II, and $\hat{v}(t\,; T_1, T_2)$ is the forward variance constructed from the corresponding long- and short-horizon spot variances. Thus, equation (8) describes the forecasting error arising from using the forward variance to proxy for the estima-

[30] Lee et al. (1991) show that marketwide sentiment contributes to the differences between prices of closed-end funds and their net asset values. Kumar and Lee (2006) use a comprehensive record of individual investor transactions to show that the factors determining the investors' trades are influenced by sentiment.

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tion of the corresponding future spot variance $v(T_1, T_2)$. A negative β coefficient suggests a negative correlation between the variance forecast errors and short-horizon variance, thereby indicating market overreaction.

To test our hypothesis relating to the impact of investor sentiment on market misreaction, we follow Yu and Yuan (2011) to analyze a two-regime regression, which extends from equation (7):

$$\Delta v_t(T_1, T_2) = \alpha_0 + \beta_0 v(t, T_1) + \alpha_1 D_t + \beta_1 D_t v(t, T_1) + \varepsilon_t, \tag{9}$$

where D_t is a dummy variable that equals 1 if month t is a high-sentiment period (a positive sentiment proxy), and 0 otherwise.

In contrast to the prior studies in which annual sentiment proxies are invariably used (Lemmon and Ni (2010), Yu and Yuan (2011)), we use monthly sentiment proxies, which gives us the advantage of updating our information more frequently. The coefficients on market misreaction for periods of high (low) sentiment consist of a combination of β_0 and β_1 (only β_0). Therefore, if investor sentiment magnifies investor misreaction, $(\beta_0 + \beta_1)$ should have a more negatively significant value.

While multiple pricing kernels may exist theoretically, empirically we focus on those estimated from options data in this study. When implementing the regressions for the transactions of any investor category, the spot variances, $v(T_1, T_2)$ and $v(t, T_1)$, are always computed from all transactions because they represent the realized information that can be observed by and known to all market participants. Conversely, the forward variance, $\hat{v}(t\,; T_1, T_2)$, is dependent on the investor category alone because it represents the prediction made by a particular category of investors.

IV. Empirical Results

A. Main Results

The first and second nearby month contracts in the Taiwan options market are invariably much more liquid than the third nearby month contracts. Therefore, our analysis focuses primarily on the regression results from the first and second nearby month (T_1 and T_2, respectively) contracts. The results from the first and third nearby month (T_1 and T_3, respectively) contracts are reported later in our robustness check. We first present the results of the impact of investor sophistication on market misreaction and then the results for the impact of investor sentiment from the marketwise prospect and across various categories of investors with different degrees of sophistication.

Table 4 provides the regression results for misreaction from the marketwise transactions and across various categories of investors. Consistent with the results reported by Jiang and Tian (2010) using marketwise data, the model-free tests of marketwise observations provide no evidence of market misreaction (the β coefficient is not negatively significant).[31] Across the different categories of investors,

[31] Following Jiang and Tian (2010), we use the model-based approach to examine the existence of market misreaction in the marketwise transactions. The results confirm their finding that this approach

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TABLE 4

Regression Results for the Existence of Misreaction

Table 4 reports the estimation results for the marketwise transactions and transactions across four categories of investors based on the following regression:

$$\Delta v_t(T_1, T_2) = \alpha + \beta v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_2)$ is as defined in equation (8); $v(t, T_1)$ refers to the spot variance implied from option prices. The sample period runs from Jan. 2002 to Dec. 2008. The *t*-statistics refer to Newey–West (1987) standard errors, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Category									
	Marketwise		Domestic Institutional Investors		Foreign Institutional Investors		Individual Investors		Market Makers	
Parameters	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.
α	−3.6858	−0.72	−0.1675	−6.98***	0.5435	1.59	−0.2910	−10.85***	−0.4457	−0.79
β	−20.2170	−0.38	−0.6961	−2.75**	−2.4166	−0.67	−0.5216	−1.84*	0.9999	0.17
R^2 (%)	0.01		0.43		0.02		0.19		0.00	

significant misreaction is discernible only for domestic institutional investors and individual investors (the β coefficients are negatively significant, with a significance level of at least 10%). Foreign institutional investors or market makers show no clear evidence of misreacting to information (the β_0 coefficients are not negatively significant). Not surprisingly, market makers do not misreact to information because they are usually liquidity providers and, hence, are inherently rational. Therefore, foreign institutional investors are the only type of sophisticated investors that does not misreact to information shocks in the TAIEX options market.

These findings, which are consistent with Jiang and Tian (2010) for the marketwise observations, support Hypothesis 1 that less sophisticated investors misreact to information more significantly than sophisticated investors. Interestingly, we find the misreaction behavior not only in the trading of individual investors but also in the trading of domestic institutional investors, even though institutional investors are usually regarded as sophisticated investors. However, our data set shows that the average holding period for domestic institutional investors is quite close to that for individual investors. This similarity suggests that domestic institutional investors in the Taiwan options market behave much like individual investors and thus that they are not as sophisticated as those in the other markets.[32]

Our findings of misreaction across investor categories are also consistent with prior studies that find the presence of heterogeneous beliefs, which may or may not be correct (Chabi-Yo et al. (2008), De Long et al. (1990), Kumar and Lee (2006), Lee et al. (1991), and Ziegler (2007)) and that report relatively poor performance for unsophisticated investors (Barber et al. (2009), Chang et al. (2009), and Mahani and Poteshman (2008)).

indicates the existence of market misreaction. However, because the model-based approach may suffer from problems of model misspecification, we focus only on the results from the model-free approach in our subsequent analysis.

[32]Based on the principle of first-in/first-out, the average holding period for securities investment trusts (dealers) is 7.3 days (5.8 days), whereas the average holding period for foreign institutional investors can be as high as 16.7 days.

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We then introduce a sentiment dummy into the model to determine whether investor sentiment drives investor misreaction. Table 5 shows that for both sentiment proxies the $(\beta_0 + \beta_1)$ coefficient is more negative than the β_0 coefficient and that only the β_1 coefficient is negatively significant at a significance level of at least 5% for individual investors and domestic institutional investors. For example, in the model in which BW9 is the sentiment index, the *t*-statistic value of the β_1 coefficient for the domestic institutional (individual investor) subsample is −4.51 (−3.81). This result indicates that the market misreaction for the two groups of investors becomes more pronounced during periods of high investor sentiment. However, the misreaction behavior exists only in periods of high investor sentiment in relation to the β_0 coefficient because all of the β_0 coefficients are statically insignificant (although most of them are still negative). By contrast, no sentiment effect occurs for the marketwise observations and the transactions of foreign institutional investors and market makers, as all of the β_1 coefficients are (positively) insignificant.[33]

TABLE 5

Regression Results for the Impact of Investor Sentiment on Misreaction

Table 5 reports the estimation results for the marketwise transactions and transactions across four categories of investors based on the following regression:

$$\Delta v_t(T_1, T_2) \quad = \quad \alpha_0 + \beta_0 v(t, T_1) + \alpha_1 D_t + \beta_1 D_t v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_2)$ is as defined in equation (8); $v(t, T_1)$ refers to the spot variance implied from option prices; and D_t is a dummy variable for the high-sentiment periods, which is identified by either one of the two investor sentiment indices: the orthogonalized BW6, which is constructed by the first principal component of the six orthogonalized sentiment proxies suggested by Baker and Wurgler (2006) and Brown and Cliff (2004); or the orthogonalized BW9, which is measured by the first principal component of the six orthogonalized sentiment proxies used to construct BW6 and three additional orthogonalized sentiment proxies, $\text{BUY_SELL}_{\text{TAIEX}}$, $\text{LONG_SHORT}_{\text{TAIFEX}}$, and $\text{CCI}_{\text{SURVEY}}$. The sample period runs from Jan. 2002 to Dec. 2008. The *t*-statistics refer to Newey–West (1987) standard errors, and *** and ** indicate significance at the 1% and 5% levels, respectively.

	Category									
	Marketwise		Domestic Institutional Investors		Foreign Institutional Investors		Individual Investors		Market Markers	
Parameters	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.
Panel A. Sentiment Index: BW6										
α_0	−0.3076	−0.46	−0.1899	−6.72	0.4745	1.17	−0.2427	−7.71***	−0.2964	−0.44
β_0	−4.2451	−0.65	−0.2218	−0.80	−6.0086	−1.52	−0.1453	−0.47	−4.2738	−0.65
α_1	−1.7490	−1.25	0.1827	3.10***	−0.7765	−0.92	−0.0235	−0.36	−1.7788	−1.27
β_1	31.1949	1.93	−2.8382	−4.18***	20.8228	2.14**	−2.0652	−2.73**	31.2803	1.94
R^2 (%)	0.24		1.47		0.45		2.08		0.24	
Panel B. Sentiment Index: BW9										
α_0	0.0982	0.14	−0.2198	−7.47***	0.6273	1.49	−0.2561	−7.82***	0.1058	0.15
β_0	−2.6226	−0.39	−0.1202	−0.43	−5.0720	−1.25	0.0276	0.09	−2.6506	−0.39
α_1	−1.8954	−1.45	0.2297	4.15***	−0.7144	−0.91	0.0364	0.60	−1.9121	−1.47
β_1	17.9293	1.21	−2.8182	−4.51***	12.9183	1.44	−2.6463	−3.81***	17.9750	1.21
R^2 (%)	0.12		1.62		0.16		2.19		0.12	

[33] Because the investor sentiment indices used in this study are compiled from the variables associated with the financial activities in the Taiwan market, they may reflect more the sentiment of domestic investors and thus have more power in picking up the misreaction of domestic investors. We thank the anonymous referee for pointing out this possible reason why we find a significant sentiment effect from the transactions of most domestic investors but not from those of foreign investors. Because the investigation on the determinants of foreign investors' trading behavior is beyond the scope of this study, we leave it for future research.

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The signs and magnitudes of the regression coefficients, in general, support Hypothesis 2, that market misreaction is more likely to exist during periods of high investor sentiment. The results also, in general, support Hypothesis 3, that the misreaction of unsophisticated investors will be more pronounced during periods of high investor sentiment. These findings offer further evidence that is consistent with Jiang and Tian (2010), as we find no misreaction for the marketwise observations regardless of the level of investor sentiment. In addition, our findings on the sentiment effect are consistent with numerous prior studies, including Chung et al. (2012), Stambaugh et al. (2012), and Yu and Yuan (2011), which report that the existence or strength of several financial anomalies is associated with investor sentiment. In particular, in line with Kumar and Lee (2006) and Lee et al. (1991), we find that individual traders are most likely to be sentiment-driven investors.

B. Further Analysis for Individual Investors

Many prior studies have found that individual investors are more likely to be sentiment traders (see, e.g., Barber and Odean (2000), (2008), Odean (1998), (1999)). Consistent with this literature, our initial results clearly show that individual investors exhibit significant misreaction to information and that such misreaction is strongly affected by investor sentiment. Therefore, we extend our investigation to examine whether discernible differences exist in the patterns of misreaction across a set of diverse characteristics of individual investors.

In particular, we are interested in the subgroup of individual investors who trade more actively or aggressively. Kuo and Lin (2013) show that these traders in the Taiwan futures market are not only overconfident on the accuracy of their information but are also biased in their interpretations of information.[34] Intuitively, active or aggressive trading is motivated by either information or overconfidence. If trading is driven by information, this subgroup should exhibit no misreaction. However, if trading is driven by overconfidence, this subgroup is likely to exhibit more severe misreaction. Although prior literature extensively examines the trading behavior of more active and aggressive investors for the equity and futures markets, to the best of our knowledge the evidence for the options market is quite limited.

We define active or aggressive individual investors over each trading day according to their trading volume and trading frequency and whether they are day traders. Specifically, our first two classifications are individual investors with daily trading volume and trading frequency, respectively, over each day within the top 20%. Our third classification is day traders, which consists of investors who complete at least 1 round-trip trade on the same trading day.

We use the transactions from the three subgroups of individual investors to compile all required implied volatility measures. Table 6 provides the regression

[34]Similar studies for the equity markets include Barber et al. (2009), Barber and Odean (1999), (2000), (2001), Jordan and Diltz (2003), and Odean (1999). This general finding is that individual investors trade more excessively and lose more money than the other groups of investors due to overconfidence.

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TABLE 6

Misreaction Estimated by the Transactions of Active or Aggressive Individual Investors

Table 6 reports the model-free estimation results for three types of active or aggressive individual investors based on the following regressions:

$$\Delta v_t(T_1, T_2) = \alpha + \beta v(t, T_1) + \varepsilon_t,$$
$$\Delta v_t(T_1, T_2) = \alpha_0 + \beta_0 v(t, T_1) + \alpha_1 D_t + \beta_1 D_t v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_2)$ is as defined in equation (8); $v(t, T_1)$ refers to the spot variance implied from option prices; and D_t is a dummy variable for the high-sentiment periods, which is identified by the BW6 or BW9 sentiment index. The active or aggressive individual investors are identified as the groups of top 20% daily trading volume, top 20% daily trading frequency, and day traders. The sample period runs from Jan. 2002 to Dec. 2008. The *t*-statistics refer to Newey–West (1987) standard errors, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Model 1			Model 2				
Parameters	β (β_0)	*t*-Stat.	R^2 (%)	β (β_0)	*t*-Stat.	β_1	*t*-Stat.	R^2 (%)
Panel A. Sentiment Index: BW6								
Top 20% daily trading volume	−0.89	−3.18***	0.58	−0.59	−1.95*	−1.61	−2.14**	2.09
Top 20% daily trading frequency	−0.84	−3.01***	0.51	−0.53	−1.77*	−1.65	−2.20**	1.98
Day traders	−1.14	−4.05***	0.95	−0.81	−2.66**	−1.69	−2.24**	4.24
Panel B. Sentiment Index: BW9								
Top 20% daily trading volume				−0.45	−1.44	−2.13	−3.09***	2.13
Top 20% daily trading frequency				−0.38	−1.24	−2.18	−3.18***	2.03
Day traders				−0.57	−1.87*	−2.67	−3.90***	5.97

results. Models 1 and 2 correspond to the regressions employed to investigate the existence of misreaction and the sentiment effect, respectively. The results of model 1 show that more active or aggressive individual investors exhibit misreaction to information shocks, which is consistent with the finding for the full sample of individual investors. However, misreaction among the three subgroups of more active or aggressive investors is much stronger. Specifically, the magnitudes of the β coefficients are larger and their significances are stronger than those for the full sample of individual investors. For example, the β coefficient for day traders is −4.05, significant at the 1% level, compared to −1.84, significant at the 10% level for the full sample of individual investors (see Table 4).

We next add a sentiment dummy variable into the regression model to explore the impact of investor sentiment. The results of model 2 in Table 6 show that the subgroup of more active or aggressive individual investors always exhibits misreaction and that investor sentiment magnifies this effect: Both the β_0 and β_1 coefficients are negatively significant at least at the 5% level. In other words, misreaction is more common among the subsample of more active and aggressive individual investors compared to the full sample of individual investors because the β_0 coefficient for the latter is insignificant.

Compared with the full sample of individual investors, the misreaction of the subgroup of more active and aggressive individual investors is much more severe and always exists, regardless of how this group of individual investors is defined. Therefore, our evidence indicates that this subgroup's activeness and aggressiveness is driven by the investors' overconfidence on the information that they obtain rather than on the information itself. This finding is consistent with prior studies that explore the trading performance of the subgroup of

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active or aggressive investors, including Barber and Odean (1999), (2000), (2001), Barber, Lee, Liu, and Odean (2014), Jordan and Diltz (2003), Kuo and Lin (2013), and Odean (1999).

Because more active or aggressive individual investors always exhibit misreaction, the question arises as to whether these investors experience any learning effect from their past prediction errors. Based on the main regression model specified by equations (7) and (8), we test the learning effect by the following regression:

$$\Delta v_t(T_1, T_2) = \alpha + (\beta + \gamma|\Delta v_{t-1}(T_1, T_2)|)v(t, T_1) + \varepsilon_t, \tag{10}$$

where $|\Delta v_{t-1}(T_1, T_2)|$ represents the previous prediction error. Because $|\Delta v_{t-1}(T_1, T_2)|$ is nonnegative, a significantly positive γ indicates that investors learn from the previous prediction error and reduce the magnitude of misreaction. By contrast, a significantly negative γ means that the previous prediction error further magnifies the degree of misreaction, and no learning effect exists.

Table 7 reports the regression results for the three groups of more active or aggressive individual investors. All of the γ coefficients are significantly negative at the 1% level of significance, and all of the β coefficients are insignificant. These findings indicate that these groups of individual traders do not learn from their past mistakes. In fact, their misreaction to information shocks is mainly driven or strengthened by their past mistakes. This finding is consistent with Gervais and Odean (2001) for the equity market and Kuo and Lin (2013) for the futures markets and suggests that in addition to not learning from their past performance, active or aggressive investors are overconfident on their past performance and consequently misreact to information shocks. Therefore, the absence of the learning effect provides additional evidence to suggest that the activeness or aggressiveness of these subgroups of individual investors is driven by overconfidence rather than information.

TABLE 7

The Learning Effect for Active or Aggressive Individual Investors

Table 7 exhibits the results of the investigation on the learning effect from past misreaction for active or aggressive individual investors. The tests are based on the following regression:

$$\Delta v_t(T_1, T_2) = \alpha + (\beta + \gamma|\Delta v_{t-1}(T_1, T_2)|)v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_2)$ and $v(t, T_1)$ are as defined in Table 4; $\Delta v_{t-1}(T_1, T_2)$ is the previous prediction error. The sample period runs from Jan. 2002 to Dec. 2008. The tests are run for the three groups of active or aggressive individual investors. The *t*-statistics refer to Newey–West (1987) standard errors, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Top 20% Daily Trading Volume		Top 20% Daily Trading Frequency		Daily Trading	
Parameter	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.
α	−0.2070	−0.37	−0.2106	−0.37	0.0706	0.12
β	4.2272	0.71	4.2441	0.71	3.6580	0.57
γ	−1.5975	−5.82***	−1.5934	−5.81***	−1.9286	−7.21***
R^2 (%)	1.92		1.91		2.95	

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V. Robustness Analyses

A. An Alternative Proxy for Investor Sentiment

Investor sentiment is more likely to remain high when the market experiences an upward trend (i.e., in bull market periods). Therefore, to enhance our previous findings on the influence of investor sentiment on market misreaction, we investigate whether asymmetry is discernible in market misreaction across different market regimes (bull vs. bear market periods; see Section II.A for definitions of bull and bear periods).

Table 8 presents the regression results for both the marketwise transactions and those of the various categories of investors with a regression model similar to equation (9), specified as

$$\Delta v_t(T_1, T_2) = \alpha_0 + \beta_0 v(t, T_1) + \alpha_1 D_{mt} + \beta_1 D_{mt} v(t, T_1) + \varepsilon_t, \quad (11)$$

where D_{mt} is a dummy variable that equals 1 if day t is classified as a day in a bull market month (m), and 0 otherwise.

TABLE 8

Regression Results under Alternative Market Regimes

Table 8 reports the estimation results for both the marketwise transactions and four categories of investors based on the following regression:

$$\Delta v_t(T_1, T_2) = \alpha_0 + \beta_0 v(t, T_1) + \alpha_1 D_{mt} + \beta_1 D_{mt} v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_2)$ and $v(t, T_1)$ are as defined in Table 4, and D_{mt} is a dummy variable that equals 1 when day t is classified as a day in a bull market month (m), and 0 otherwise. The bull market periods include May 2003 to Mar. 2004 and Sept. 2004 to Nov. 2007, and the bear market periods include Apr. to Oct. 2002, Mar. to Aug. 2004, and Dec. 2007 to Dec. 2008. The t-statistics refer to Newey–West (1987) standard errors, and *** and ** indicate significance at the 1% and 5% levels, respectively.

	Category									
	Marketwise		Domestic Institutional Investors		Foreign Institutional Investors		Individual Investors		Market Makers	
Parameters	Coeff.	t-Stat.	Coeff.	t-Stat.	Coeff.	t-Stat.	Coeff.	t-Stat.	Coeff.	t-Stat.
α_0	−1.6109	−1.82	−0.2373	−6.36***	0.1630	0.31	−0.5297	−12.89***	−0.5163	−12.50***
β_0	6.5925	0.91	−0.2813	−0.92	−0.9945	−0.23	0.8132	2.40**	0.7452	2.19**
α_1	1.1659	0.87	0.1215	2.15**	0.1258	0.16	0.3622	5.83***	0.3647	5.84***
β_1	11.4183	0.52	−0.8913	−0.96	11.5058	0.87	−1.4188	−1.39	−1.5353	−1.49
R^2 (%)	0.25		0.07		0.17		3.50		3.48	

Consistent with our previous marketwise results, we find no misreaction for the marketwise observations, which do not depend on market regimes. Of the various categories of investors, individual investors and domestic institutional investors exhibit the most obvious symmetry in the misreaction across different market regimes. However, although the β_1 coefficients are negative, the asymmetric misreaction is insignificant. In other words, these two groups of investors become more optimistic in a bull market and tend to misreact to information, but the change is not statistically significant. By contrast, we do not find a negative β_1 coefficient for the other groups of investors; that is, we find no evidence of any asymmetric misreaction. By and large, these findings are consistent with our previous findings with the two alternative sentiment indices and add insights to the

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extant literature by showing general support for the impact of investor sentiment on the trading behavior of investors.

B. An Alternative Definition for Long- and Short-Term Horizons

Because the theories in prior studies on market misreaction provide no guidance on how long- and short-term periods should be defined, we provide a check for robustness based on the first and third (T_1 and T_3, respectively) nearby contracts. The results, which are presented in Tables 9 and 10, correspond with the results reported in Tables 4 and 5 for the tests on the existence of misreaction and on the sentiment effect, respectively.

TABLE 9

Robustness Check on the Existence of Misreaction with an Alternative Duration

Table 9 reports the estimation results for the marketwise observations and transactions across four categories of investors based on the following regression:

$$\Delta v_t(T_1, T_3) \quad = \quad \alpha + \beta v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_3)$ is as defined in equation (8), replaced the long-horizon maturity with T_3; $v(t, T_1)$ refers to the spot variance implied from option prices. The sample period runs from Jan. 2002 to Dec. 2008. The *t*-statistics refer to Newey–West (1987) standard errors, and *** and ** indicate significance at the 1% and 5% levels, respectively.

	Category									
	Marketwise		Domestic Institutional Investors		Foreign Institutional Investors		Individual Investors		Market Makers	
Parameters	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.
α	−0.1311	−0.73	−0.1087	−5.83***	0.5298	2.04**	−1.5957	−14.70***	−0.0145	−0.05
β	−0.4507	−0.24	0.7147	3.40***	3.2148	0.98	−2.8848	−2.51**	3.4851	1.06
R^2 (%)	0.00		0.66		0.05		0.36		0.06	

The results are, in general, consistent with those obtained from the first and second nearby contracts; in other words, the model-free tests show no evidence of market misreaction and sentiment effect in the marketwise transactions. Furthermore, of the four categories of investors, only individual investors exhibit significant misreaction to information, with such misreaction being more pronounced during periods of high sentiment. The β coefficient in Table 9 is −2.88 with a *t*-statistic of −2.51, and the β_1 coefficient with BW6 in Table 10 is −8.15 with a *t*-statistic of −2.94. In contrast to the results based on the first and second (T_1 and T_2, respectively) nearby contracts, we find no significant evidence for the existence of market misreaction and sentiment effect from the transactions of the domestic institutional investors. Therefore, the regression results from the two alternative definitions of long- and short-term horizons jointly suggest that individual investors are the only category of investors that exhibits misreaction with the sentiment effect.

Finally, we conduct a robustness check based on alternative maturity groups for the different reclassifications of active or aggressive individual investors. Table 11 reports the results, which are similar to those reported on the first and second nearby contracts (see Table 6). All types of active or aggressive individual investors tend to misreact to information, particularly when investor sentiment is high, with such misreaction being particularly driven by investor sentiment.

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TABLE 10

Robustness Check on the Sentiment Effect with an Alternative Duration

Table 10 reports the estimation results for the marketwise transactions and transactions across four categories of investors based on the following regression:

$$\Delta v_t(T_1, T_3) = \alpha_0 + \beta_0 v(t, T_1) + \alpha_1 D_t + \beta_1 D_t v(t, T_1) + \varepsilon_t,$$

where $\Delta v_t(T_1, T_2)$ is as defined in equation (8), replacing the long-horizon maturity with T_3; $v(t, T_1)$ refers to the spot variance implied from option prices; and D_t is a dummy variable for the high-sentiment periods, which is identified by either of the two investor sentiment indices: the orthogonalized BW6, which is constructed by the first principal component of the six orthogonalized sentiment proxies suggested by Baker and Wurgler (2006) and Brown and Cliff (2004); or the orthogonalized BW9, which is measured by the first principal component of the six orthogonalized sentiment proxies used to construct BW6 and three additional orthogonalized sentiment proxies, $\text{BUY_SELL}_{\text{TAIEX}}$, $\text{LONG_SHORT}_{\text{TAIFEX}}$, and $\text{CCI}_{\text{SURVEY}}$. The sample period runs from Jan. 2002 to Dec. 2008. The *t*-statistics refer to Newey–West (1987) standard errors, and *** and ** indicate significance at the 1% and 5% levels, respectively.

	Category									
	Marketwise		Domestic Institutional Investors		Foreign Institutional Investors		Individual Investors		Market Makers	
Parameters	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.	Coeff.	*t*-Stat.
Panel A. Sentiment Index: BW6										
α_0	−0.3647	−1.72	0.0000	0.00	0.8946	2.62**	−1.9588	−15.30***	−0.3363	−0.92
β_0	−2.1934	−1.03	−0.0010	−0.00	0.4676	0.12	−1.3918	−1.07	−1.0646	−0.29
α_1	0.3699	0.89	−0.3119	−7.97***	−0.9111	−1.71	1.2232	4.89***	0.1759	0.24
β_1	6.2491	1.36	2.6252	5.61***	9.1520	1.23	−8.1516	−2.94**	17.8198	2.23**
R^2 (%)	0.85		4.19		0.23		1.93		1.14	
Panel B. Sentiment Index: BW9										
α_0	−0.3599	−1.62*	0.0000	0.00	1.0658	2.92**	−1.9797	−14.79***	−1.7062	−8.34***
β_0	−2.7439	−1.30	−0.0000	−0.00	−0.1934	−0.05	−2.1676	−1.69*	−1.9389	−0.99
α_1	−0.0211	−0.05	−0.2739	−7.06***	−1.1374	−2.16**	0.9156	3.73***	−0.7995	−2.12**
β_1	12.1102	2.58**	2.4906	5.12***	10.7360	1.32	−2.9419	−1.04	11.5530	2.64**
R^2 (%)	1.15		3.45		0.32		1.87		0.40	

TABLE 11

Robustness Check on the Misreaction of Active or Aggressive Individual Investors with an Alternative Duration

Table 11 reports the model-free estimation results for three types of more active or aggressive individual investors with an alternative duration over the full sample period. The more active or aggressive individual investors are identified as the groups of top 20% daily trading volume, top 20% daily trading frequency, and day traders. The *t*-statistics refer to Newey–West (1987) standard errors, and *** and ** indicate significance at the 1% and 5% levels, respectively.

	Model 1			Model 2				
Parameters	β (β_0)	*t*-Stat.	R^2 (%)	β (β_0)	*t*-Stat.	β_1	*t*-Stat.	R^2 (%)
Panel A. Sentiment Index: BW6								
Top 20% daily trading volume	−1.48	−1.87**	0.20	−0.36	−0.41	−4.71	−2.46**	0.71
Top 20% daily trading frequency	−3.99	−3.83***	0.84	−2.36	−2.01**	−7.90	−3.12***	1.49
Day traders	−3.95	−4.35***	1.09	−2.66	−2.60**	−6.36	−2.87**	1.65
Panel B. Sentiment Index: BW9								
Top 20% daily trading volume				−0.17	−0.19	−6.51	−3.32***	0.90
Top 20% daily trading frequency				−1.72	−2.66**	−5.49	−3.83***	2.98
Day traders				−2.99	−2.95**	−4.65	−2.05**	1.46

VI. Conclusion

Although the finance literature identifies both pros and cons in the anomalies observed in the options market, the empirical results of the prior studies are quite mixed. Therefore, we provide a more in-depth investigation of the anomalies

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based on a unique data set, which includes comprehensive records of all transactions undertaken within the well-developed options market of Taiwan.

Motivated by the prior studies that associate heterogeneous beliefs, investor sophistication, investor sentiment, and mispricing in the options markets, we place particular focus on an examination of the anomalies from the perspective of investor sophistication and investor sentiment to investigate their impact on the existence and, if so, the strength of market misreaction. In addition to different categories of investors classified by their degrees of sophistication, we also explore the patterns of misreaction for the subgroup of more active or aggressive individual investors. Our empirical findings provide plausible explanations for the anomalies found in the options market and also help to consolidate the contradictory findings within the extant literature.

In particular, we find that individual investors exhibit significant misreaction to information, with such misreaction becoming much more pronounced during periods of high investor sentiment. In addition, although domestic institutional investors are usually seen as sophisticated investors, their patterns of misreaction can sometimes be quite similar to those of individual investors. We find that more active or aggressive individual investors always misreact to information shocks and never learn from their past mistakes, which suggests that their activeness or aggressiveness is driven by overconfidence rather than information.

These misreaction patterns are robust to alternative measures of investor sentiment and definitions of long- and short-term horizons. Thus, our findings confirm that the anomalies in the options markets are largely dependent on the level of sophistication of the associated investors and that investor sentiment affects the strength of these anomalies. Overall, our empirical results are in line with the prior studies with the arguments of heterogeneous beliefs, sentiment-driven investors, and overconfidence.

References

Baker, M., and J. Wurgler. "Investor Sentiment and the Cross-Section of Stock Returns." *Journal of Finance*, 61 (2006), 1645–1680.

Baker, M., and J. Wurgler. "Investor Sentiment and the Stock Market." *Journal of Economic Perspectives*, 21 (2007), 129–151.

Barber, B. M.; Y.-T. Lee; Y.-J. Liu; and T. Odean. "Just How Much Do Individual Investors Lose by Trading?" *Review of Financial Studies*, 22 (2009), 609–632.

Barber, B. M.; Y.-T. Lee; Y.-J. Liu; and T. Odean. "The Cross-Section of Speculator Skill: Evidence from Day Trading." *Journal of Financial Markets*, 18 (2014), 1–24.

Barber, B. M., and T. Odean. "The Courage of Misguided Convictions: The Trading Behavior of Individual Investors." *Financial Analysts Journal*, 55 (1999), 41–55.

Barber, B. M., and T. Odean. "Trading Is Hazardous to Your Wealth: The Common Stock Investment Performance of Individual Investors." *Journal of Finance*, 55 (2000), 773–806.

Barber, B. M., and T. Odean. "Boys Will Be Boys: Gender, Overconfidence, and Common Stock Investment." *Quarterly Journal of Economics*, 116 (2001), 261–292.

Barber, B. M., and T. Odean. "All That Glitters: The Effect of Attention and News on the Buying Behavior of Individual and Institutional Investors." *Review of Financial Studies*, 21 (2008), 785–818.

Black, F., and M. Scholes. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy*, 81 (1973), 637–659.

Bollen, N., and R. Whaley. "Does Net Buying Pressure Affect the Shape of Implied Volatility Functions?" *Journal of Finance*, 59 (2004), 711–753.

Britten-Jones, M., and A. Neuberger. "Option Prices, Implied Price Processes and Stochastic Volatility." *Journal of Finance*, 55 (2000), 839–866.

https://doi.org/10.1017/S0022109015000290 Published online by Cambridge University Press

Brown, G. W., and M. T. Cliff. "Investor Sentiment and the Near-Term Stock Market." *Journal of Empirical Finance*, 11 (2004), 1–27.
Brown, G. W., and M. T. Cliff. "Investor Sentiment and Asset Valuation." *Journal of Business*, 78 (2005), 405–440.
Chabi-Yo, F.; R. Garcia; and E. Renault. "State Dependence Can Explain the Risk Aversion Puzzle." *Review of Financial Studies*, 21 (2008), 973–1011.
Chang, C.-C.; P.-F. Hsieh; and H.-N. Lai. "Do Informed Option Investors Predict Stock Returns? Evidence from the Taiwan Stock Exchange." *Journal of Banking and Finance*, 33 (2009), 757–764.
Chang, C.-C.; P.-F. Hsieh; C.-W. Tang; and Y.-H. Wang. "The Intraday Behavior of Information Misreaction Across Various Categories of Investors in the Taiwan Options Market." *Journal of Financial Markets*, 16 (2013), 362–385.
Chao, C.; H. Li; and F. Yu. "Is Investor Misreaction Economically Significant? Evidence from Short- and Long-Term S&P 500 Index Options." *Journal of Futures Markets*, 25 (2005), 717–752.
Chung, S.-L.; C.-H. Hung; and C.-Y. Yeh. "When Does Investor Sentiment Predict Stock Returns?" *Journal of Empirical Finance*, 19 (2012), 217–240.
Coval, J. D., and T. Shumway. "Do Behavior Biases Affect Prices?" *Journal of Finance*, 60 (2005), 1–34.
Daniel, K.; D. Hershleifer; and A. Subrahmanyam. "Investor Psychology and Security Market Under- and Overreactions." *Journal of Finance*, 52 (1998), 1839–1885.
Daniel, K., and S. Titman. "Evidence on the Characteristics of Cross Sectional Variations in Stock Returns." *Journal of Finance*, 52 (1997), 1–33.
De Bondt, W. F. M., and R. H. Thaler. "Does the Stock Market Overreact?" *Journal of Finance*, 40 (1985), 793–808.
De Long, J. B.; A. Shleifer; L. H. Summers; and R. J. Waldmann. "Positive Feedback Investment Strategies and Destabilizing Rational Speculation." *Journal of Finance*, 45 (1990), 379–396.
Figlewski, S. "Option Arbitrage in Imperfect Markets." *Journal of Finance*, 44 (1989), 1289–1311.
Gervais, S., and T. Odean. "Learning To Be Overconfident." *Review of Financial Studies*, 14 (2001), 1–27.
Green, T. C., and S. Figlewski. "Market Risk and Model Risk for a Financial Institution Writing Options." *Journal of Finance*, 54 (1999), 1465–1499.
Han, B. "Investor Sentiment and Option Prices." *Review of Financial Studies*, 21 (2008), 387–414.
Harrison, J. M., and D. M. Kreps. "Martingales and Arbitrage in Multiperiod Securities Markets." *Journal of Economic Theory*, 20 (1979), 381–408.
Harrison, J. M., and S. R. Pliska. "Martingales and Stochastic Integrals in the Theory of Continuous Trading." *Stochastic Processes and Their Applications*, 11 (1981), 215–260.
Hens, T., and C. Reichlin. "Three Solutions to the Pricing Kernel Puzzle." *Review of Finance*, 17 (2013), 1065–1098.
Hong, H., and J. C. Stein. "A Unified Theory of Under-Reaction, Momentum Trading and Overreaction in Asset Markets." *Journal of Finance*, 54 (1999), 2143–2184.
Jiang, G. J., and Y. S. Tian. "The Model-Free Implied Volatility and Its Information Content." *Review of Financial Studies*, 18 (2005), 1305–1342.
Jiang, G. J., and Y. S. Tian. "Extracting Model-Free Volatility from Option Prices: An Examination of the VIX Index." *Journal of Derivatives*, 14 (2007), 35–60.
Jiang, G. J., and Y. S. Tian. "Misreaction or Misspecification? A Re-Examination of Volatility Anomalies." *Journal of Banking and Finance*, 34 (2010), 2358–2369.
Jordan, D. J., and J. D. Diltz. "The Profitability of Day Traders." *Financial Analysts Journal*, 59 (2003), 85–95.
Kumar, A., and C. M. C. Lee. "Retail Investor Sentiment and Return Comovements." *Journal of Finance*, 61 (2006), 2451–2486.
Kuo, W.-Y., and T.-C. Lin. "Overconfident Individual Day Traders: Evidence from the Taiwan Futures Market." *Journal of Banking and Finance*, 37 (2013), 3548–3561.
Kurov, A. "Investor Sentiment and the Stock Market's Reaction to Monetary Policy." *Journal of Banking and Finance*, 34 (2010), 139–149.
Lakonishok, J.; I. Lee; N. D. Pearson; and A. M. Poteshman. "Option Market Activity." *Review of Financial Studies*, 20 (2007), 813–857.
Lakonishok, J.; A. Shleifer; and R. Vishny. "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance*, 49 (1994), 1541–1578.
Lee, C.; A. Shleifer; and R. Thaler. "Investment Sentiment and the Closed-End Fund Puzzle." *Journal of Finance*, 46 (1991), 75–109.
Lemmon, M., and S. X. Ni. "The Effects of Investor Sentiment on Speculative Trading and Prices of Stock and Index Options." Working Paper, University of Utah (2010).

https://doi.org/10.1017/S0022109015000290 Published online by Cambridge University Press

Lemmon, M., and E. Portniaguina. "Consumer Confidence and Asset Prices: Some Empirical Evidence." *Review of Financial Studies*, 19 (2006), 1499–1529.
Mahani, R. S., and A. M. Poteshman. "Overreaction to Stock Market News and Misevaluation of Stock Prices by Unsophisticated Investors: Evidence from the Option Market." *Journal of Empirical Finance*, 15 (2008), 635–655.
Newey, W., and K. West. "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica*, 55 (1987), 703–708.
Odean, T. "Are Investors Reluctant to Realize Their Losses?" *Journal of Finance*, 53 (1998), 1775–1798.
Odean, T. "Do Investors Trade Too Much?" *American Economic Review*, 89 (1999), 1279–1298.
Ofek, E.; M. Richardson; and R. Whitelaw. "Limited Arbitrage and Short Sales Restrictions: Evidence from the Options Markets." *Journal of Financial Economics*, 74 (2004), 305–342.
Pan, J., and A. M. Poteshman. "The Information in Option Volume for Future Stock Prices." *Review of Financial Studies*, 19 (2006), 871–908.
Polkovnichenko, V., and F. Zhao. "Probability Weighting Functions Implied by Options Prices." *Journal of Financial Economics*, 107 (2013), 580–609.
Poteshman, A. M. "Underreaction, Overreaction, and Increasing Misreaction to Information in the Options Market." *Journal of Finance*, 56 (2001), 851–876.
Shefrin, H. *A Behavioral Approach to Asset Pricing*. Amsterdam, The Netherlands: Elsevier (2005).
Shleifer, A. *Inefficient Markets: An Introduction to Behavioral Finance*. Oxford, UK: Oxford University Press (2000).
Shleifer, A., and R. W. Vishny. "The Limits of Arbitrage." *Journal of Finance*, 62 (1997), 35–55.
Stambaugh, R. F.; J. Yu; and Y. Yuan. "The Short of It: Investor Sentiment and Anomalies." *Journal of Financial Economics*, 104 (2012), 288–302.
Stein, J. "Overreactions in the Options Market." *Journal of Finance*, 44 (1989), 1011–1023.
Tetlock, P. C. "Giving Content to Investor Sentiment: The Role of Media in the Stock Market." *Journal of Finance*, 62 (2007), 1139–1168.
Yu, J., and Y. Yuan. "Investor Sentiment and the Mean–Variance Relation." *Journal of Financial Economics*, 100 (2011), 367–381.
Ziegler, A. "Why Does Implied Risk Aversion Smile?" *Review of Financial Studies*, 20 (2007), 859–904.

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