

The Impact of Foreign Investor Sentiment on Taiwan's Stock and Futures Markets

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Abstract

By utilizing the market-adjusted relative turnover to filter out the macroeconomic impacts, we construct “foreign investor sentiment index” in Taiwan and analyze how excess returns, volatility, and cash-futures market correlation are affected by this index. Our results show that foreign investor sentiment has a positive effect on excess returns and cash-futures market correlation, but has a negative impact on volatility. Moreover, both foreign investor sentiment index and net inward remittance of foreign investor (NIRFI) have a good prediction power in cash market's excess returns.

Key words: Market-adjusted relative turnover, foreign investor sentiment index, cash-futures market correlation

I. Introduction

Since 1980s, behavioral finance scholars have found that there are many phenomena in the financial markets that violate the efficient market hypotheses. These phenomena cannot be explained from the perspective of rational investors, and the impact of “investor sentiment” on the financial markets is one

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of these phenomena that has attracted much attention. According to Hirshleifer (2015), “*Investor sentiment* is the fluctuating general attitude toward investment categories... It can be associated with shifts in assessments of expected returns or of risk... Such shifts can be magnified by self-reinforcing social processes induced by media bias or conformity effects.” (p. 36).

Most of the literature on investor sentiment focuses on the general investor, with only a few exceptions addressing the impacts of institutional investors. For example, Sanders, Irwin, and Leuthold (1997) find that the bullish market sentiment index is predictive of the futures market. Similarly, Wang (2001) uses large traders’ holdings in the futures market as the proxy variable for investor sentiment and finds that it can help predict the futures’ returns. Simon and Wiggins (2001) analyze the relation between sentiment variables (such as volatility index (*VIX*), put-call ratio (*PCR*), trading index (*TRIN*), and the S&P500 futures return (*SPXFTR*)). They also conclude that sentiment variables can predict the futures’ returns and that *VIX*, *PCR*, and *TRIN* are useful reverse indicators for sentiment. Lee, Jiang, and Indro (2002) find that there was a close relationship between investor sentiment, market volatility, and excess return, Barber, Odean, and Zhu (2009) find that investor sentiment was positively related to the short-term stock prices but negatively related to the long-term stock prices.

In Taiwan’s financial markets, “foreign investment” has increasing influence on individual or other institutional investors. Foreign investors include foreign institutional investors (*FINI*) and overseas Chinese and foreign individuals (*FIDI*). As the amount of *FINI* accounts for 99% of foreign investment, in this paper we use data from *FINI* mainly. Table AI in Appendix A shows the historical statistics of foreign investment in Taiwan. Notice that the cumulative net foreign exchange shows a yearly increasing trend (see Figure 1). Figures 2 to 4 show the increasing patterns of foreign investment in “the proportion of total holdings,” “the proportion of futures trading volumes,” and “the proportion of the option trading volumes.”

When we address the foreign investment impacts in Taiwan’s financial markets, it is important to study the influence of foreign investor sentiment. That is, if, as described, the sentiment indexes have the ability to predict futures returns, market volatility, and excess returns, then by observing the foreign investor sentiment, individuals or other institutional investors may follow suit or counteract to their trading activities. This may “enhance or reduce” the relation between foreign investor sentiment and the market volatility and excess returns in the cash and futures stock markets. Moreover, if the foreign investor sentiment index is predictive, it is of great importance for individuals, other institutional investors, and financial authorities to read the foreign investors trading strategies behind the sentiment.

Table I
Foreign Investment in Taiwan Stock Market

Sources: Financial Supervisory Board, Taiwan Stock Exchange, and ROC Securities Counter Trading Center.

Item	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Inward Remittance of Foreign Investors (Billion USD)	65.358	99.153	117.203	159.047	174.148	134.800	138.377	143.468	122.161	132.829	131.189
Outward Remittance of Foreign Investors	51.608	70.289	95.545	152.095	186.998	108.171	123.706	153.518	114.793	119.648	114.643
Net Inward Remittance of Foreign Investors	13.750	28.864	21.658	6.952	-12.850	26.629	14.671	-10.050	7.368	13.181	16.546
Accumulated Net Inward Remittance of Foreign Investors (Billion USD)	80.090	108.954	130.612	137.602	124.765	151.343	165.758	155.965	163.332	176.513	191.604
Foreign Institutional Investors (FINI)	80.065	108.921	130.581	137.532	124.689	151.250	165.649	155.644	162.842	176.037	191.181
Foreign Individual Investors (FIDI)	0.025	0.033	0.031	0.070	0.076	0.093	0.109	0.321	0.490	0.476	0.423
Foreign Investors Net Buy/Net Sell (100 Million NTD)	2,713	7,915	5,523	814	-4,950	5,106	2,914	-2,653	1,442	2,565	3,977
Total Buy	33,322	39,876	49,946	69,730	63,849	53,551	56,966	59,847	49,609	51,810	60,859
Total Sell	30,609	31,961	44,423	68,916	68,799	48,445	54,051	62,500	48,167	49,246	56,882
Percentage of Market Value by Foreign Investors (%)	22.180	30.250	31.900	31.100	28.980	29.800	31.190	31.100	32.620	33.140	36.430

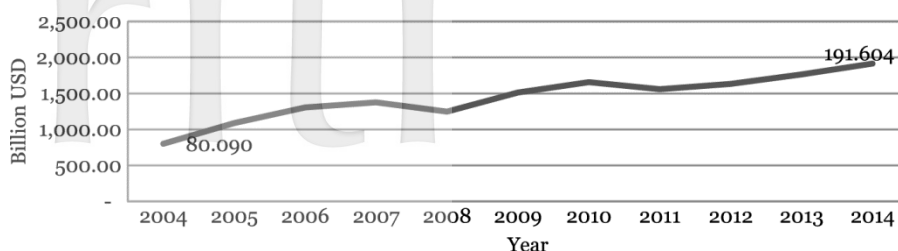


Figure 1. Amount of Net Inward Remittance of Foreign Investors into Taiwan Stock Market

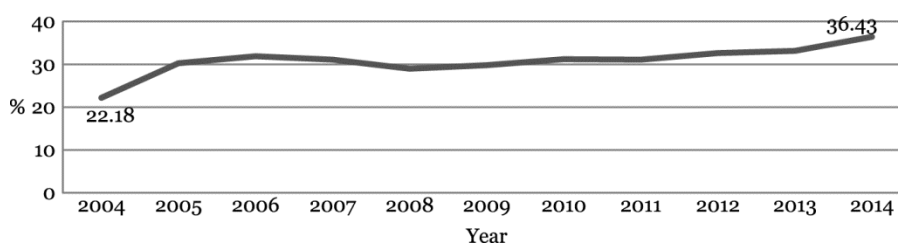


Figure 2. Proportion of Market Value Held by Foreign Investors by Year

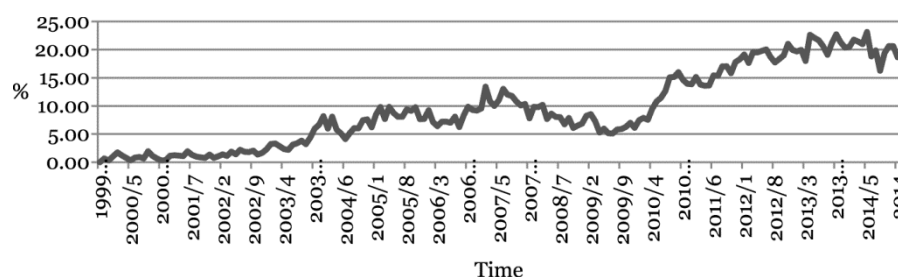


Figure 3. Proportion of Foreign Investors' Trading Volume in Taiwan Futures Market

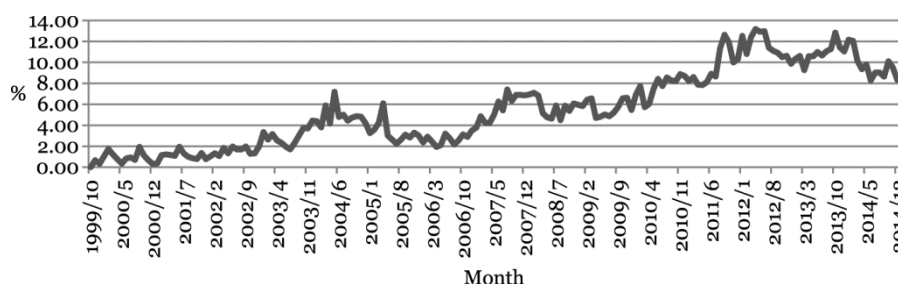


Figure 4. Proportion of Foreign Investors' Trading Volume in Taiwan Option Market

The purpose of this paper is to analyze the impacts of “foreign investor sentiment” on Taiwan’s cash and futures stock markets, and to address their implications on foreign investors’ trading strategies. Most of the literature uses proxy variables to measure investor sentiment. For example, Simon and Wiggins (2001) use volatility index, put-call ratio, and trading index to measure

sentiment. Baker and Wurgler (2006) use the principal component analysis to composite a sentiment index by using the explanatory variances from several sentiment proxy variables.

In this paper, we consider five proxy variables for foreign investor sentiment: net inflow remittance of foreign investor (*NIRFI*), normalized turnover rate (*NTOR*), buy-sell imbalance (*BSI*), put-call ratio (*PCR*) and net positions on open interest of foreign investors (*NPOI*). Following Baker and Wurgler's (2006) approach, we use the principal component analysis to composite a sentiment index from these five proxy variables. However, as pointed by Chou, Zhang, and Lin (2007), Taiwan's investor sentiment is susceptible to macroeconomic factors. To exclude the influence of these factors, we follow Connolly and Stivers (2003) by using the market adjusted relative turnover (*MRTO*) as the proxy for macroeconomic factors. Then by applying the principal component analysis again, we exclude the effect of *MRTO* from the first-stage sentiment index.

Next, we use a Bivariate EGARCH-X-MA (1) model to investigate the impacts of foreign investor sentiment on the excess returns, volatility, and cross-market correlation between cash and futures stock markets. These dependent variables are chosen for two reasons. First, as mentioned, most of the existing literature analyzes the impacts of general investor sentiment and finds that there are significant effects on excess returns and volatility. Second, as foreign investors often trade across spot and future markets, we hence infer that foreign investor sentiment should have an unneglectable impact on the correlation between two markets. On the one hand, the high investor sentiment may lead to an increase in transactions noises, which will increase the exposure risk to institutional investors. In order to reduce the exposure risk, the foreign investors would reduce transactions, thus reducing the interaction and correlation between the two markets. On the other hand, if the foreign institutional investors' trading activities or holding strategies induce the herding effect, it may enhance the cross-market trading activities and increase the interaction and correlation between two markets.

Our main results are the following. (i) The foreign investor sentiment index has positive impact on excess returns in both cash and futures stock markets, and the magnitude is higher in the futures market. In bullish periods, foreign investors trade more in the low-cost and high leverage futures markets to gain excess returns; while in bearish periods, the foreign investors take advantage of their quality information to obtain better excess returns. (ii) As for the impacts on volatility, we find that with high sentiment, foreign investors will adjust their holdings to reduce exposure risk, thus reducing the market volatility. In other words, foreign investors play an important role in stabilizing the cash and futures stock markets. (iii) We find that the foreign investor sentiment index has significant impacts on the spot-futures market correlation. This indicates that with high sentiment, foreign investor may speculate across the cash and futures

markets, thus increasing the cross-market correlation. (iv) The U.S. quantitative easing (QE) policy has a significant impact on excess returns, volatility, and the cross-market correlation. (v) The robustness tests find similar results in most cases. (vi) Foreign investor sentiment index has good predictability for the foreign investor net inflow remittance in the cash stock market.

The remainder of the paper is organized as follows. Section II provides a brief review on related literature. Section III describes data sources, and theoretical and empirical models used in our research. Section IV presents the empirical results. Section V concludes with remarks.

II. Related Literature

Most existing literature on “institutional investors” addresses the impacts on stock price, and most studies on foreign investment focus on the impacts on stock returns and volatility. There is no contribution addressing the impacts from foreign investors’ sentiment. Here we briefly review the four hypotheses of “institutional investors,” and then the results regarding the influence from foreign investment.

A. Institutional Investors’ Impacts on Stock Prices

There are four hypotheses regarding the impacts of institutional investors on stock prices: (a) Price Pressure and Pull Hypothesis. Shleifer (1986) argues that each security has its own demand and supply curves. When institutional investors sell (buy) securities, the excess supply (demand) will push down (pull up) the stock price. (b) Information Effect Hypothesis. Since institutional investors have better information than the general investors, so their buying or selling decisions partly reveal the private information behind. Close (1975) points out that since large transaction volumes may carry important information, other investors could react by re-evaluating the stock value, thus affecting the stock price. De Long et al. (1990) suggest that if noise traders adopt a positive feedback trading strategy, then the transactions by the rational investors’ will increase the market volatility. Kraus and Stoll (1972) study the large transactions in NYSE, and find out that after a large volume of buy in, the stock price will increase. (c) Liquidity Effect Hypothesis. Scholes (1972) argues that when large transactions happen in one security, there will be excess supply, which cannot be matched with demand spontaneously (due to large volume). Hence transaction costs occur, and these costs also affect the actual transaction price (see also Kraus and Stoll (1972)). (d) Parallel Trading Hypothesis. Kraus and Stoll (1972) suggest that there will be a herding effect following institutional investors’ transactions. The magnitude of buying or selling will be enlarged, hence increasing the volatility.

Wermers (1999) and Nofsinger and Sias (1999) find that institutional investors' buying activities have a strong positive effect on quarterly and annual returns. Griffin, Harris, and Topaloglu (2003) study the daily transactions of the Nasdaq 100 and find that the daily returns are positively related to institutional investors' trading activities. Chan and Lakonishok (1993), Bozcuk and Lasfer (2005), and Sias, Starks, and Titman (2006) study institutional investors' selling and buying transactions, and find that buying transactions have a relatively higher and longer impact on stock prices. Reilly and Wright (1984) examine the 10-day moving average trading volumes, and find a significant negative correlation between stock volatility and large transactions.

B. Impacts of Foreign Investment

Foreign investors have professional research teams, whose experienced trading strategies and large funds often bring them high returns. Hence, their trading timing and decisions have become an important reference for individuals and other institutional investors. Taiwan relies heavily on international trades, and the cash and futures stock markets are significantly affected by the international markets. Compared to the local institutional investors, foreign investors have better overseas information and are able to response quickly to international events and have better returns.

B.1. Foreign Investors, Stock Returns, and Volatility

Richards (2005) finds that foreign transactions and share returns are positively related. Adaoglu and Katircioglu (2013) study the relationship between foreign investment and Turkish stock returns before and after Turkey's joined in EU. The results show that the monthly returns were affecting net foreign capital inflow before joining in EU, while the causality disappeared after joining EU. Wang (2014) uses a bivariate VAR model to show the positive correlation between foreign capital flows and the A-share returns in China. Schuppli and Bohl (2010) study the deregulation of foreign ownership of the A-shares in China, and find that foreign investments not only effectively reduce the volatility but also enhance market efficiency.

There have been extensive studies on the impacts of foreign investment on Taiwan's stock returns. For example, Chuang, Cheng, and Chiu (2003) point out that there exists causality between foreign investors' transactions and the stock index returns. Lu, Wong, and Fang (2008) find that the holdings adjusted by foreign investors will incur a herding effect, because the holdings adjustment is usually related to excess returns. By using the three-factor model of Fama and French (1993), Chiao, Cheng, and Shao (2006) show that Taiwan's investors take advantage of the foreign investors' transactions (holdings and holdings variances) and gain abnormal rate of returns. Hsu, Wang, and Huang (2010)

point out that following the three large institutions' block buying (selling), the next day stock price will increase (decrease) significantly.

B.2. Foreign investors are the Information-Advantage Traders

Kamesaka, Nofsinger, and Kawakita (2003) argue that foreign investment in the securities market is often seen as an information advantage trader. Froot, O'Connell, and Seasholes (2001) find that the net inflow of foreign capital had a significant positive predictive power for emerging market returns, in line with the general view that foreign investors had better private information in emerging markets. Many researchers have point out that foreign capital has a wealth of international investment experience (e.g., Froot and Ramadorai (2001), Hamao and Mei (2001), Seasholes (2004), Grinblatt and Keloharju (2000), Froot, O'Connell, and Seasholes (2001), and Karolyi (2002)). Some studies suggest that compared with local institutions or individual investors, foreign investors' performance is better due to their sophisticated retrieval and interpretation of new information.

Yu and Lai (1999) point out that foreign investors enjoy information leading phenomenon in the short market period, showing that foreign investors have better quality market information, so that they could respond to market information ahead of other investors. Huang (2000) explores the concept that foreign investor's buying is a leading indicator to other institutional investors and broader market indices. Chen (2001) studies the existence of a causal relationship between the change in the Taiwan weighted index and the net buy/sell of the three major institutional investors. In particular, foreign investors play a leading role both in the rise and fall of the weighted index and operations of investment trust and dealers throughout the study period. In addition, Chang, Hsieh, and Lai (2009) find that the foreign investor's trading information regarding options indicates a significant and effective forecast of the cash market's returns.

The above related literature shows that foreign investors not only enjoy the leading role of the information trading in the securities market, but also their trading behavior can have significant influence on the trading in cash, futures, and option markets. However, there are many other studies showing that the trading behavior of institutional investors (or foreign institutions) is not closely related to information: For example, it may be due to irrational psychological factors (Friedman (1984)), or involved with agent problem (Scharfstein and Stein (1990)); institutional investors' herding behavior was to obtain a satisfactory price level (Falkenstein (1996)). In addition, Nofsinger and Sias (1999) argue that institutional investors have a greater degree of feedback behavior than individual investors.

C. An Empirical Study on Investor Sentiment in Taiwan Stock Market

To our knowledge, both domestic and foreign literature regarding the impact of investment sentiment is for general investors. There is little literature devoted to the study of the impact of “foreign investment sentiment” on the market (excess) return, volatility, and correlation, among which the study of the correlation of the futures and spot markets is very little. The following supplements the existing literature on empirical study of Taiwan’s investment sentiment.

First, Hsu, Kuo, and Chang (2005) find no significant difference in the impact of market volatility between the long and short markets. They also find that the fluctuation of the difference in margin debt was related to the previous stock price volatility, which implied that in Taiwan stock the retail investor sentiment is more susceptible to the stock market volatility when compared to institutional investor sentiment. Cheng and Lin (2010) show that the impact of investor sentiment on the higher speculative stock returns is of more magnitude, but considering the three factors of Fama and French (1993), the relationship is not clearly confirmed.

Hsieh (2008) explores the relationship between the four major sentiment indicators and the TX index futures and finds that: (a) TX index futures returns are negatively influenced by the put-call ratio of open interest, the put-call ratio of trading volume, and the VIX, while short-selling over margin is positive to futures returns; (b) the response of VIX and short-selling over margin to negative return is greater than that of positive return (that is, asymmetric impact); (c) TX index futures returns lead to the sentiment (e.g., put-call ratio of open interest and put-call ratio of trading volume); (d) the above-mentioned sentiment indicators are little related to the future returns, but the high extreme sentiment indicators can be regarded as reverse indicators, except for low extreme sentiment indicators. Lin, Li, and Yeh (2012) find that the mid and short-term momentum effect and low sentiment losers are closely related; and the mid-term price reversal phenomena is very closely related to high sentiment losers. In addition, Chou, Zhang, and Lin (2007) show that the performance of the stock market was partly affected by the macroeconomic risk and the irrational sentimental response of investors, and they point that investor sentiment was affected by the prevailing economic environment. Moreover, investor sentiment and market returns are currently related to each other, thus affecting the future market returns.

Lu, Lee, and Chiu (2014) find that foreign investor sentiment affects the future TX index futures returns more greatly than those of other institutional investors. Additionally, foreign investor sentiment impacts the domestic institutional investors’ sentiment. Cheng and Lin (2010) use turnover rate, net buy/sell shares, and net buy/sell trading volume of futures as a proxy for

institutional investor sentiment and show that the net buy/sell shares traded by the three major institutional investors significantly affected the concurrent (subsequent) excess returns of shares, and the influence was much stronger with higher concentration of speculative trading stocks. Chen, Lee, and Liao (2016) use long and short open interest positions of Taiwan futures market as the proxy variables for institutional investors sentiment and find that foreign investor sentiment has a positive relationship with the subsequent futures returns, in line with the market risk sentiment hypothesis (such as Frijns, Koellen, and Lehnert (2008)); but for futures dealers, it is a negative relationship, which corresponds to sentimental demand shock hypothesis (Baker and Wurgler (2006)). Finally, Yang and Wu (2011) use Taiwan cash trading data (volume, trading orders) on behalf of the foreign sentiment variables and evidence that the foreign investor is the least affected by the price volatility, followed by investment trust and security dealers.

D. An Empirical Study on Foreign Institutional Investor Sentiment

Lee, Jiang, and Indro (2002) find that institutional investor sentiment (e.g., investor intelligence) was positively related to excess return; Bull (bear) sentiment would lead to a decrease (increase) in future volatility. Brown and Cliff (2004) divide investors into two categories: institutional investors and general investors, and find that there was a significant correlation between institutional investor sentiment and large stock returns. Schmeling (2007) argues that institutional investor sentiment can correctly predict future stock market returns. Huerta, Egly, and Escobari (2016) use the GARCH-M model to study the impact of investor sentiment on the real estate investment trust (REIT) industry during the 2007-2009 financial crisis period, and the results show that institutional investor sentiment could increase excess return and decrease volatility, as compared to individual investor sentiment. Sayim and Rahman (2015) point out that both return and volatility of the Istanbul Stock Market (ISE) are affected by the spillover effect of U.S. investor sentiment, especially the sentimental spillover of institutional investors being greater than that of individual investors. Moreover, a negative relationship is found between the U.S. investor sentiment and the stock market volatility in TSE.

E. Importance of Study on Foreign Investment Sentiment

There is much research on “investor sentiment” pertaining to the Taiwan securities markets, but research on “foreign investor sentiment” is rare. Understanding of foreign investment behavior or strategy has always been an important topic of the existing literature, but the discussion of how foreign investor sentiment affects returns, volatility, and cross-market correlation is inadequate. This study addresses the inadequacies of the literature and explores

how foreign investor sentiment, together with individual robustness tests, affects the excess market returns, volatility, and cross-market correlation. In addition, this study builds a more complete foreign investor sentiment indicator model and its research on the futures and cash markets. To construct a foreign investor sentiment indicator, we use market-adjusted relative turnover (hereafter, *MRTO*) as a proxy variable for the macroeconomics to obtain orthogonal sentiment indicators. When individual sentiment proxy variable is the daily observation frequency (unlike Baker and Wurgler (2006)), *MRTO* is a desirable proxy variable that is easy to obtain and calculate. As for the main empirical model of this paper, the major results are mostly homogeneous with the empirical findings reported in Appendix C, based on the methodology of Baker and Wurgler (2006).

III. Research Methodologies

We consider five proxy variables for foreign investor sentiment: net inflow remittance of foreign investors (*NIRFI*), normalized turnover rate (*NTOR*), buy-sell imbalance (*BSI*), put-call ratio (*PCR*), and net positions on open interest of foreign investors (*NPOI*). Section III.A. depicts the explicit definitions and the related literature for these proxy variables. Next, Section III.B. describes how we follow Baker and Wurgler's (2006) approach, and construct a sentiment index from these proxy variables. As described earlier, we will use *MRTO* to exclude the influence from macroeconomic factors. We first show how *MRTO* closely relates to other macroeconomic variables, including exchange rate, interest spread, annual growth rate of price index, inflation rate, industrial production index, unemployment rate, M1B, M2, and government debt (see Chen (2009)). These microeconomic variables cover changes in *financial* markets, price volatility, economic activity, and monetary and fiscal policies. The results, reported in Appendix A, show that most variables are significantly associated with *MRTO*, except for the annual growth rate of price index and unemployment rate. Finally, by applying the principal component analysis, we exclude the effect of *MRTO* from the first-stage sentiment index. Section III.C. describes the empirical model of this paper.

A. Selection and Definitions of Sentiment Proxy Variables

We choose the five proxy variables to represent foreign investors' sentiment in foreign exchange, spot, futures, and option markets. Our sample covers the period from 2009 to 2014. The reason for choosing this duration is as follows. The 2008-2009 financial crisis ended in the first half of 2009. The U.S. QE policy created abundant funds, which caused tremendous capital inflows to Taiwan markets. As the foreign investors trade across different countries and

have access to better information, their sentiment status becomes very informative of their trading strategies. However, since the sampling period covers the U.S. QE policy, we will compare the impacts for during and after the QE in our robust analysis. Table II summarizes the definitions of the five sentiment proxy variables.

Table II
Five Proxy Variables for Foreign Investor Sentiment

+(-) indicates the relatedness between proxy variables and the index.

Market	Variable	Definition	
Foreign Exchange			
Net Inward Remittance of Foreign Investor	<i>NIRFI</i>	(Accumulated amount of net inward remittance on day t)-(Accumulated amount of net inward remittance on day $t-1$)	+
Stock Market			
Normalized Turnover Rate	<i>NTOR</i>	$TOR = \text{Ln} \left[\frac{(\text{Net buy shares by foreign investors on day } t)}{\text{Outsatndng shares of market on day } t} \times 100 \right]$ $NTOR = TOR / TMA$, TMA =denotes the average of TOR over the 50 days prior to day t .	+
Buy-Sell Imbalance	<i>BSI</i>	$BSI = \frac{\text{Ln}(ASB_t) - \text{Ln}(ASS_t)}{\text{Ln}(ASB_t) + \text{Ln}(ASS_t)} \times 100$ ASB_t (ASS_t) denotes the trading values of shares bought(sold) by foreign investors on day t .	+
Option Market			
Put-Call Ratio	<i>PCR</i>	(Put in open interest)/(Call in open interest)	-
Futures Market			
Net Positions on Open Interest of Foreign Investor	<i>NPOI</i>	$NPOI = \frac{AP - \text{Min}(AP)}{\text{Max}(AP) - \text{Min}(AP)}$, $AP = \frac{\text{Ln}(NOIL_t) - \text{Ln}(NOIS_t)}{\text{Ln}(NOIL_t) + \text{Ln}(NOIS_t)}$ $NOIL_t$ represents net long positions of foreign investors in day t , while $NOIS_t$ denotes net short positions of foreign investors in day t . $\text{Max}(AP)$ and $\text{Min}(AP)$ denote the AP 's maximum and minimum net positions over the 50 days prior to day t .	+

- (1) Net Inward Remittance of Foreign Investors (*NIRFI*): Baek (2006) shows that international funds invest in Asian financial markets as the markets are affected more by global market mood and other external conditions¹ than by the fundamentals. Griffin, Nardari, and Stulz (2004) study nine emerging markets and found that the net equity flows to Asia is not only affected by their market performance, but also by the performance in international markets (e.g., U.S.A.) and other non-fundamental reasons, among which market sentiment may be an important factor driving the international capital flows. Froot, O'Connell, and Seasholes (2001) argue that foreign

¹ External conditions include global interest rates, stock market performance, economic growth, and various crises.

investors have better information in emerging markets, so the net inflow of foreign capital has a significant positive predictive power for asset prices in emerging markets. Figure 5 indicates that the net inflow remittance of foreign investors shares the similar pattern with the indexes of Taiwan's cash and futures market.

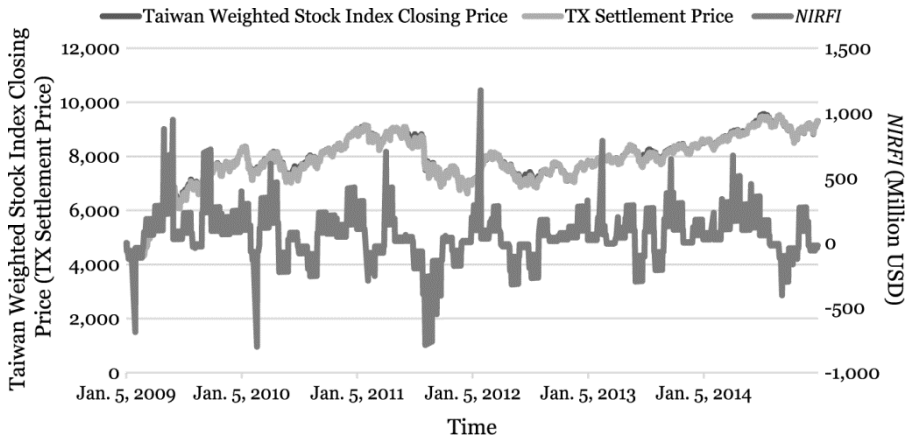


Figure 5. Net Inward Remittance of Foreign Investors (*NIRFI*) vs. Taiwan Cash and Futures Market's Indexes

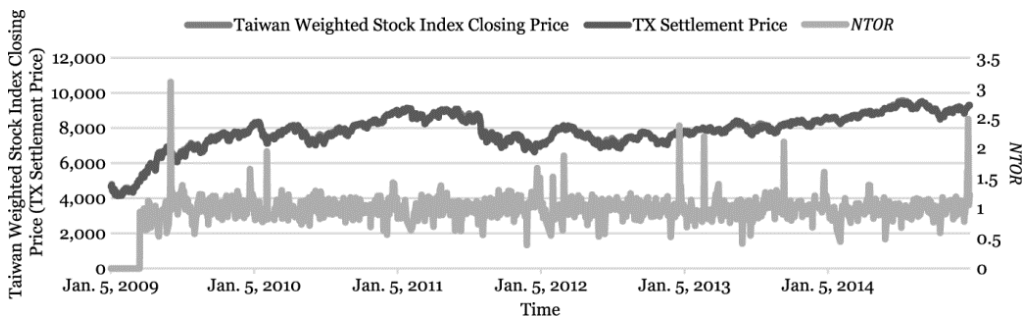


Figure 6. Normalized Turnover Rate (*NTOR*) vs. Taiwan Cash and Futures Market's Indexes

- (2) Normalized Turnover Rate (*NTOR*): Harrison and Kreps (1978) and Scheinkman and Xiong (2003) find a positive relation between sentiment and turnover rates. They suggest that turnover rates provide trading signals; namely, when the turnover rate is high, it may be accompanied by overreacting investors. Baker and Stein (2002) and Baker and Wurgler (2006) also demonstrate that turnover rates can be used as a sentiment proxy variable. Jones (2001) discovers a negative relation between turnover rates and market returns. Chiao, Chen, and Huang (2011) find that when the market goes up, foreign investors are more optimistic and they will purchase more small, young, and low dividend securities; on the contrary, when the

market goes down, foreign investors tend to be pessimistic and they will sell young, low-dividend and high risk securities. This indicates that the turnover rates are in association with the foreign investors' sentiment status. Figure 6 compares the patterns of normalized turnover rate and price index of Taiwan's cash and futures market.

- (3) Buy-Sell Imbalance (*BSI*): Malliaris and Urrutia (1998) describe that the increase in trading volume indicates that the securities are more competitive and hence trading volume is one of the important factors for price volatility. Wiley and Daigler (1998) find that the volume of transactions can reflect the market's demand and supply, and hence have a significant relation with volatility. Kumar and Lee (2006) use *BSI* to indicate the investment sentiment. When the investment sentiment is high (low), investors tend to buy in (sell out), and hence *BSI* serves as a good proxy for foreign investor's sentiment. Figure 7 depicts the relation between *BSI* and price index of Taiwan's cash and futures market. Chiang, Tsai, and Lee (2011) also utilize *BSI* to measure the general investors' sentiment in Taiwan markets. When $BSI > 0$, foreign investors have excess demand for securities, thus leading to more investors to upgrade their expectations and become optimistic. Contrarily, when $BSI < 0$, foreign investors have excess supply for securities, thus leading to more investors to downgrade their expectations and become pessimistic.

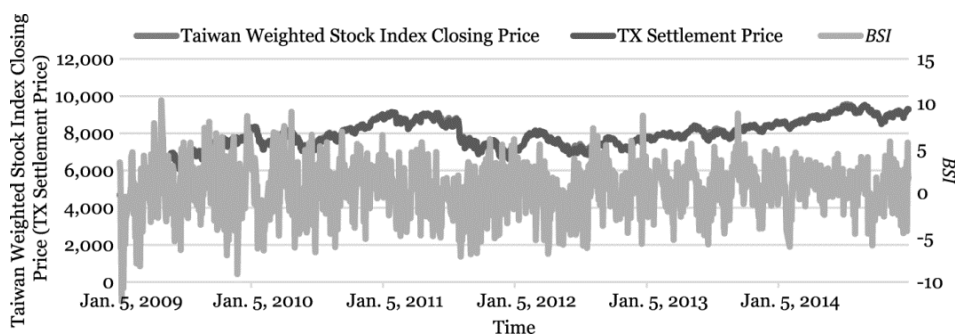


Figure 7. Buy-Sell Imbalance (*BSI*) vs. Taiwan Cash and Futures Market's Indexes

- (4) Put-Call Ratio (*PCR*): The put-call ratio has been taken as a useful signal for trading and as an index for fear in the market. High *PCR* indicates that the market is in a bearish atmosphere, indicating that investors buy put options to avoid position risk or to speculate, while low *PCR* indicates that there is an excess demand for call options. Simon and Wiggins (2001) describe that *PCR* is an important index of both statistical and economic predictability. Shefrin (1999) uses *PCR*, Investors Intelligence, and America Association of Individual Investors as the market sentiment proxies and shows that *PCR* is

the most predictive variable for stock price return (see also Bhuyan (2002)). Hsu, Kuo, and Chang (2005) find that high *PCR* indicates that the market atmosphere is more bearish, and low *PCR* indicates that the market is more bullish (see Figure 8).

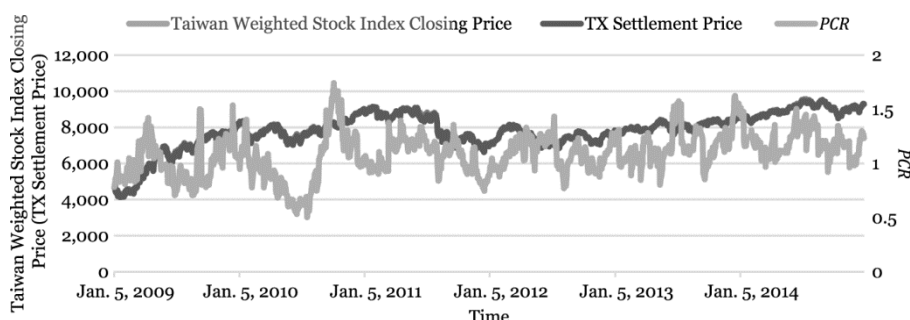


Figure 8. Put-Call Ratio (*PCR*) vs. Taiwan Cash and Futures Market's Indexes

- (5) Net Positions on Open Interest of Foreign Investors (*NPOI*): Wang (2001) uses *NPOI* as the sentiment proxy variable, and Tornell and Yuan (2012) point out that *NPOI* can indicate the relative position of stock prices, and help anticipate future price changes. For example, when the position is in historical high or low, it indicates that the foreign investors are optimistic or pessimistic about the market, and hence *NPOI* provides a useful judgement for buying or selling. In Taiwan the foreign investors' trading activities have always been important references for other types of investors, and hence *NPOI* also plays the role of guiding the market. Moreover, *NPOI* has a negative impact on price, but a positive impact on volatility. Huang, Ni, and Lai (2011) study Taiwan's cash stock market, and find that when open interest position increases, it indicates that foreign investors are optimistic and the market will continue to heat up. But if open interest position decreases, foreign investors are pessimistic and the market will turn down. Our paper follows Wang's (2001) definition of *NPOI* whose details are given in Table II. The patterns of *NPOI* and price index of Taiwan's cash and futures market are shown in Figure 9.

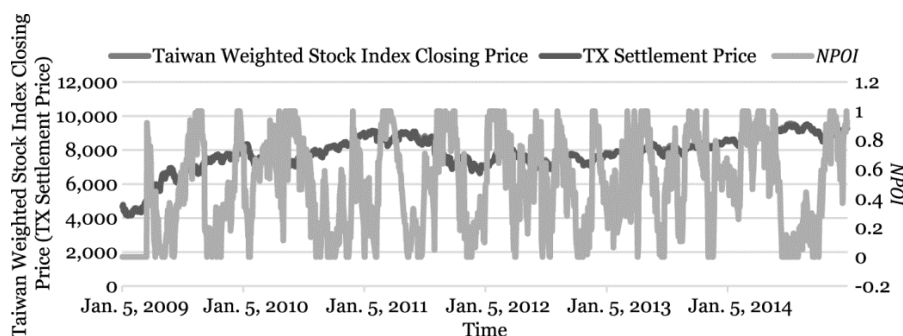


Figure 9. Net Positions on Open Interest of Foreign Investors (*NPOI*) vs. Taiwan Cash and Futures Market's Indexes

B. Constructing the Foreign Investor Sentiment Index

Following Baker and Wurgler's (2006) approach, we use the principal component analysis to composite a sentiment index from these five proxy variables. However, as pointed out by Chou, Zhang, and Lin (2007), Taiwan's investor sentiment is susceptible to macroeconomic factors. To exclude the influence of these factors, we first follow Connolly and Stivers (2003) by using *MRTO* as the proxy for macroeconomic factors. Then, by applying the principal component analysis again, we exclude the effect of *MRTO* from the first-stage sentiment index. The details are given as follows.

Firstly, according to Connolly and Stivers (2003), we set up the following equation.

$$TO_t = \gamma_0 + \sum_{k=1}^{12} \gamma_k TO_{t-k} + \gamma_{13} |R_{s,t}| + \gamma_{14} D_t^- |R_{s,t}| + \gamma_{15} |R_{s,t-1}| + \gamma_{16} D_{t-1}^- |R_{ts,-1}| + \mu_t, (1)$$

where

TO_t = Logarithm of Taiwan stock market turnover rate,

$R_{s,t}$ = Taiwan stock index excess return = (logarithmic index return-riskless interest rate/365)×100, where risk-less rate equal to average of one-year deposit rates for five leading domestic banks, and

D_t^- = dummy variable, whose value is one if $R_{s,t} < 0$; otherwise, it is zero.

According to the Box-Ljung $Q(24)$ tests, the optimal lag period is 12 months, in which case the residual (μ_t) will indicate the market's relative turnover rate.

Secondly, since the proxy variables have different measures, we find the correlation matrix for these proxy variables first. Then we use the principal component analysis to composite the first stage sentiment index from these five proxy variables. We keep the component with highest eigenvalue and construct the first stage index using the associated eigenvector. Then we find the correlation between this first stage index and the current and lag one period values of each proxy variable. We keep the variables (among the current and lag one period value of the proxy variable) with the highest correlations. Then we proceed with the second stage principal component analysis with these variables, keep the component with eigenvalue greater than one, and extract the second stage sentiment index.² We calculate the correction between the first and second stage index to test for information revelation. Finally, we regress the second stage sentiment index on *MRTO* to exclude the macroeconomic factors as follows.

$$SENTIMENT_{FI,t} = a + b \times MRTO_t + \varepsilon_t. (2)$$

² As suggested by Baker and Wurgler (2006), in the principal component analysis (PCA) we preserve the eigenvalues of more than one, and use them to calculate the weighted average of the first and second principal components, which is the investor sentiment index.

The final sentiment index, $SENT_{FI,t}$, is the residual of this regression equation.³

C. Empirical Models

According to the literature on investors sentiment, we expect that (a) the foreign investor sentiment index has impacts on excess returns in both cash and futures stock markets; (b) the foreign sentiment index also influences the spot and futures market volatility; (c) as foreign investors often trade across spot and future markets, we hence infer that foreign investor sentiment should have an impact on the correlation between the two markets.

C.1. Foreign Investor Sentiment and Excess Return

We set up a Bivariate EGARCH-X-MA (1) model to analyze the impact of foreign investor sentiment on the stock market's excess returns in Equation (3), and on the futures market's excess returns in Equation (4).

$$R_{st} = \beta_{10} + \beta_{11} \times ECT_{t-1} + \beta_{12} \times R_{s,t-1} + \beta_{13} \times R_{f,t-1} + qf_{11} \times SENT_{FI,t} + ma_{10} \times \varepsilon_{s,t-1} + \varepsilon_{s,t}, \quad (3)$$

$$R_{ft} = \beta_{20} + \beta_{21} \times ECT_{t-1} + \beta_{22} \times R_{f,t-1} + \beta_{23} \times R_{s,t-1} + qf_{21} \times SENT_{FI,t} + ma_{20} \times \varepsilon_{f,t-1} + \varepsilon_{f,t}, \quad (4)$$

where

R_{st} : Stock market's excess returns (%) in period $t = (\text{logarithmic index return} - \text{riskless interest rate}/365) \times 100$,

R_{ft} : Futures market's excess returns (%) in period $t = (\text{logarithmic index futures return} - \text{riskless interest rate}/365) \times 100$,

$SENT_{FI,t}$: Index of foreign investor sentiment,

ECT_t : Error Correction term,⁴

$\varepsilon_{s,t}$: Regression error terms for cash market's excess return,

$\varepsilon_{f,t}$: Regression error terms for futures market's excess return.

We assume that $\varepsilon_t = (\varepsilon_{s,t} \ \varepsilon_{f,t})' \sim N(0, H_t)$, where $H_t = \begin{pmatrix} h_{s,t} & h_{sf,t} \\ h_{fs,t} & h_{f,t} \end{pmatrix}$ is the variance-covariance matrix for the cash and futures market's excess returns. To incorporate the frictions from transaction costs and low frequency trading, we add in a moving average term (i.e., ma) in the regression models.

Brown and Cliff (2004) argue that investor sentiment is highly correlated with the current market return. Specifically, when speculators believe that the

³ In the subsequent robustness test, the empirical results of the U.S. QE policy are given only in Equation (2) that one additional term, $MRT O_{t-1}$, is augmented to guarantee convergence of parameter estimates.

⁴ According to Johansen and Juselius (1990), we define $ECT_t = (P_{f,t} - 1.011184P_{s,t}) \times 100$, where P_t is the logarithm of the spot or futures market price.

actual value of the asset is above (below) the current price, they tend to be optimistic (pessimistic). Moreover, our literature review shows that the impacts of market sentiment could be different under bearish or bullish atmosphere. Hence we expect that when foreign investors are in high sentiment, indicating their optimistic overviews, there will be positive excess returns and hence the parameters for sentiment index should be positive. On the other hand, when foreign investors are in low sentiment, indicating their pessimistic overviews, there will be negative excess returns and hence the parameters for sentiment index should be negative.

C.2. Foreign Investor Sentiment and Market Volatility

Equations (7) and (8) explore how foreign investor sentiment affects the spot and futures market volatility, respectively. The literature has pointed out that ignoring the asymmetry in volatility could lead to misevaluation in volatility (e.g., French, Schwert, and Stambaugh (1987), Nelson (1991) and Glosten, Jagannathan, and Runkle (1993)). Hence, according to Nelson (1991), we use G_s and G_f (i.e., Equations (5) and (6)) to adjust the asymmetry between stock return and volatility. Specifically, in the regression models (7) and (8) we add in the variables $G_{s,t-1}$ and $G_{f,t-1}$ to represent the asymmetry. The definitions of G_s and G_f are given as:

$$G_{s,t} = \left| \frac{\varepsilon_{s,t}}{\sqrt{h_{s,t}}} \right| - E \left| \frac{\varepsilon_{s,t}}{\sqrt{h_{s,t}}} \right| + dt_s \times \frac{\varepsilon_{s,t}}{\sqrt{h_{s,t}}}, \quad (5)$$

$$G_{f,t} = \left| \frac{\varepsilon_{f,t}}{\sqrt{h_{f,t}}} \right| - E \left| \frac{\varepsilon_{f,t}}{\sqrt{h_{f,t}}} \right| + dt_f \times \frac{\varepsilon_{f,t}}{\sqrt{h_{f,t}}}, \quad (6)$$

where

$\left| \frac{\varepsilon_{s,t}}{\sqrt{h_{s,t}}} \right|$: Absolute value of the cash market's standardized residuals,

$\left| \frac{\varepsilon_{f,t}}{\sqrt{h_{f,t}}} \right|$: Absolute value of the futures market's standardized residuals,

$E \left| \frac{\varepsilon_{s,t}}{\sqrt{h_{s,t}}} \right| = \sqrt{\frac{2}{\pi}}$: Expected value of the absolute value of the cash market's standardized residuals,

$E \left| \frac{\varepsilon_{f,t}}{\sqrt{h_{f,t}}} \right| = \sqrt{\frac{2}{\pi}}$: Expected value of the absolute value of the future market's standardized residuals.

Equations (7) and (8) investigate the impacts of foreign investor sentiment on the spot and futures market volatility, respectively.

$$\begin{aligned} h_{s,t} = & \exp[vc_{11} + va_{11} \times \ln(h_{s,t-1}) + va_{12} \times \ln(h_{s,t-2}) + vb_{11} \times G_{s,t-1} \\ & + vb_{12} \times G_{f,t-1} + d_{10} \times SENT_{FI,t-1}, \end{aligned} \quad (7)$$

$$h_{f,t} = \exp[vc_{22} + va_{22} \times \ln(h_{f,t-1}) + va_{22} \times \ln(h_{f,t-2}) + vb_{21} \times G_{f,t-1} + vb_{22} \times G_{s,t-1} + d_{20} \times SENT_{FI,t-1}], \quad (8)$$

where

$h_{s,t}$: Excess return variance in cash stock market at time t .

$h_{f,t}$: Excess return variance in futures market at time t .

When the return in spot (futures) market decreases, if the parameters of dt_s (dt_f) in (5) and (6) are significantly negative and the parameters of vb_{11} (vb_{21}) in (7) and (8) are positive, it means that bad news will trigger the increase in volatility, showing the leverage effect in spot (futures) market. Contrarily, when the return in spot (futures) market increases, if the parameters of dt_s (dt_f) in (5) and (6) are significantly positive and the parameters of vb_{11} (vb_{21}) in (7) and (8) are positive, it means that good news will cause the increase in volatility, showing the adverse leverage effect in spot (futures) markets. Whether there is a cross market spillover effect depends on whether the parameters of vb_{12} (vb_{22}) are significant.

Corredor, Ferrer, and Santamaria (2013) find that institutional investors in high sentiment status tend to reduce their positions to reduce the exposure risk, thus leading to decreases in volatility. Huang (2000) find that in both centralized and over-the-counter markets, the net buy/sell volatility in the previous period has a negative effect on the stock price volatility in the next period. In other words, this is evidence that institutional investors can reduce market volatility. Our paper shares this point of view. Foreign investors allocate their funds across different regions up to predetermined proportions. When they are in high sentiment, they will reduce positions to avoid exposure risk, and hence reduce market volatility. Hence we expect that the parameters of d_{10} and d_{20} in (7) and (8) are negative. Moreover, since it needs more professional knowledge to participate in the highly risky futures market, we expect that foreign investors could stabilize the futures market.

C.3. Foreign Investor Sentiment and Cross-Market Correlation

As foreign investors often trade across spot and future markets, we infer that foreign investor sentiment should have an impact on the correlation between the two markets. Following Bollerslev's (1990) setup of constant conditional correlation, we assume that the proportion of covariance ($h_{sf,t}$) over the product of standard error is constant ($=\rho$), and add in the sentiment index into the following equation.

$$h_{sf,t} = (\rho + d \times SENT_{FI,t}) \times \sqrt{h_{s,t} \times h_{f,t}}, \quad (9)$$

where the definition of $h_{sf,t}$ ($= h_{f,s,t}$) is previously given in the definition of variance-covariance matrix for spot and future market excess return H_t . ρ and d

are the parameters to be estimated.

Bohl, Salm, and Wilfling (2011) find that when the market is efficient, the correlation between cash and futures stock markets would increase as institutional investors actively participate in market transactions. Hence, we figure that high foreign investor sentiment has a positive impact on the cross market correlation. In bullish periods, foreign investors buy in cash stock market and take positions in the futures market, both of which lead to increase in the cross-market correlation. In bearish periods, foreign investors sell in cash stock market and reduce positions in the futures market, both of which also lead to increase in the cross-market correlation. Moreover, Chan and Lakonishok (1993), Bozcuk and Lasfer (2005), and Sias, Starks, and Titman (2006) find that institutional investor's buying transactions affect the stock price with a larger scale and last longer. Hence we expect that the parameter of $SENT_{FI,t}$ (i.e., d) to be positive.

IV. Empirical Analysis

A. Data Description

The data used in this paper is collected from CMoney, TEJ, Financial Supervisory Commission, Taiwan Stock Exchange, Taipei Exchange, and Taiwan Futures Exchange. The data includes the settlement price of TX index futures, the closing price and turnover rate of Taiwan weighted index, net inward remittance of foreign investors (monthly data), turnover rate of foreign investors, net trading volumes of foreign investors, foreign investor's open interest of futures, and put-call ratio of options' open interests of foreign investors. The study period spans from January 5, 2009 to December 31, 2014 for a total of six years and 1,493 daily observations.

A.1. Proxy Variable for Foreign Investor Sentiment

The global financial crisis triggered by the U.S. subprime mortgage crisis put the world into the most serious recession since the 1929 market downturn and depression. The DJIA, S&P500, Nasdaq, Nikkei 225, and Hang Seng indexes all reached relative low points around in the first week of March, 2009. Since then, global stock markets have started to rebound. As for Taiwan's foreign investors, futures' open interest reached the highest number of contracts (43,616) on the February 23, 2009 and in the cash market, both the number of net-buy shares, 1,008,641 (thousand shares) and the amount of net-buy trading values, 14,299 (million NTD) reached the relative maximum on April 30, 2009. This also made the cash market returns in the day reach the relative maximum of 6.74% and the futures market returns in the next business day (May 4, 2009) reach a relative

maximum of 7.00%.⁵

Regarding the descriptive statistics reported in Table III, the means of the individual sentiment variables are all statistically significant, which gives the basis for building up the sentiment index of foreign investor. In addition, excess kurtosis and first-lag autocorrelation are significant. Furthermore, all variables are stationary according to PP unit root test. It is worth noting that the mean of cash market turnover rate is significant, while both the mean and first-lag autocorrelation of *MRTO* by construction is not statistically significant.

Table III
Descriptive Statistics of Cash Market Turnover (*MRTO*), Excess Returns and Individual Proxy Variables for Sentiment

TO represents the turnover rate of Taiwan cash market (%) while *MRTO* is the market relative-adjusted turnover rate. *R_t* indicates excess return of cash and futures markets (%). *NIRFI* is the net inward remittance of foreign investor (million USD). *NTOR* is the normalized turnover rate of foreign investor (%). *BSI* represents net buy/sell values (%). *PCR* is put-call ratio on open interest of foreign investors (%). *NPOI* is net position on open interest of foreign investors. Kurtosis indicates excess kurtosis. Rho(1) is the first-lag autocorrelation. ***, **, and * represent significance level at 1%, 5%, and 10%, respectively.

Variable	Mean	Medium	SD	Skewness	Kurtosis	PP Unit Root	Rho(1)
<i>TO</i>	-0.4245***	-0.4286	0.2766	0.1945***	0.3586***	-10.0266***	0.8314**
<i>MRTO</i>	0.0000	0.0037	0.1275	-0.1043	0.7255***	-39.7491***	-0.0332
<i>R_{st}</i>	0.0425	0.0877	1.1062	-0.3126***	3.3657***	-35.5245***	0.0808***
<i>R_{ft}</i>	0.0428	0.0877	1.1971	-0.2998***	4.5437***	-36.7684***	0.0480*
<i>NIRFI</i>	45.5382***	42.2164	151.8045	0.4784***	8.6888***	-20.1997***	0.5687***
<i>NTOR</i>	0.9724***	0.9963	0.2437	-1.0226***	12.6174***	-15.6501***	0.7014***
<i>BSI</i>	0.2310***	0.2961	1.6370	-0.1943***	0.8989***	-22.7977***	0.4906***
<i>PCR</i>	1.0893***	1.1029	0.1971	-0.0476	0.3820***	-6.0328***	0.9525***
<i>NPOI</i>	0.4896***	0.5105	0.3203	-0.0278	-1.2537***	-7.2798***	0.9239***

A.2. Construction of Foreign Investor's Sentiment Index

We first conduct the first-stage PCA and the resultant sentiment index is shown as follows:

$$\begin{aligned}
 SENT_{1t} = & 0.2288 \times FINIR_t + 0.2206 \times FINIR_{t-1} + 0.0849 \times NTOR_t + 0.0855 \\
 & \times NTOR_t + 0.3581 \times BSI_t + 0.3471 \times BSI_{t-1} + 0.2980 \times PCR_t - 0.2946(10) \\
 & \times PCR_{t-1} + 0.4735 \times NTOI_t + 0.4857 \times NTOI_{t-1}.
 \end{aligned}$$

Equation (10) shows that only the *PCR* in period *t* and *t-1* is negatively related to *SENT₁*, while other variables are positively related to *SENT₁*, a finding in line with the expected signs that are previously discussed.

⁵ As for foreign investors, these statistical numbers are provided by Taiwan Security Exchange and Taiwan Futures Exchange.

We then proceed to the second-stage PCA to produce the final sentiment index. We compare the variables in periods t and $t-1$ with the relatively high correlation (i.e., the loading of the factor) with the $SENT_1$ of the first stage, and conduct the second PCA to obtain the components with eigenvalues greater than one (e.g., $SENT_{PC1,t}$ and $SENT_{PC2,t}$). It is noted that the accumulated eigenvalues account for 51.96%. Thus, the resultant sentiment indexes, shown in Equation (11), are used to calculate the weighted average score according to the eigenvalue size.

$$\begin{aligned} SENT_{PC1,t} &= 0.4944 \times FINIR_t + 0.1990 \times NTOR_{t-1} + 0.6520 \times BSI_t - 0.1931 \\ &\quad \times PCR_{t-1} + 0.5035 \times NPOI_t, \\ SENT_{PC2,t} &= 0.5078 \times FINIR_t + 0.2390 \times NTOR_{t-1} + 0.7829 \times BSI_t + 0.2319 \\ &\quad \times PCR_{t-1} - 0.6047 \times NPOI_t. \end{aligned} \quad (11)$$

Tables BI to BVIII of Appendix B report all the eigenvalues, eigenvectors, correlation coefficient matrices, and factor loadings of the first and second PCA, respectively. According to $SENT_{PC1,t}$ of Equation (11), we can see that only PCR is still negatively related to sentiment index. Note that the highest weight with $SENT_t$ is BSI , followed by $NPOI$, and then the $NIRFI$. Further, the correlation of the first-stage and the second-stage sentiment indexes is 0.8810, indicating that most of the information is still retained. Finally, the orthogonalized sentiment index, $SENT_{FI,t}$, can be obtained according to Equation (2).

B. Analysis of Empirical Results

In this paper, we use the maximum likelihood estimation (MLE) to estimate the parameters of the bivariate EGARCH Model augmented with conditional excess return equations of both the cash and futures markets under the assumption of normal distribution from Equations (3) through (9):

$$L(\theta) = -\frac{T}{2} \log 2\pi - \frac{1}{2} \sum_{t=1}^T (\log(|H_t|) + \varepsilon_t' H_t^{-1} \varepsilon_t), \quad (12)$$

where θ is the parameter vector to be estimated and the algorithm of Broyden-Fletcher-Goldfarb-Shanno (BFGS) is easily implemented and useful for the estimation of θ .

Before analyzing the empirical results, we perform the following tests on the variables of interest: unit-root test, co-integration test, serial correlation test, ARCH test, and Engle and Ng test. The test results show that all variables are stationary. Furthermore, the trace test of Johansen and Juselius (1990) confirms co-integration between cash and futures prices. Additionally, ARCH effects and asymmetric volatility in the cash and futures markets are detected. Therefore, this paper adopts the EGARCH model.⁶

⁶ To save space, some preliminary statistical results are not reported here but they are available upon request.

B.1. Foreign Investor Sentiment and Excess Returns

Table IV describes the effect of foreign investor sentiment on excess returns of cash and futures markets. Equations (3) and (4) are restated as follows:

$$R_{st} = \beta_{10} + \beta_{11} \times ECT_{t-1} + \beta_{12} \times R_{s,t-1} + \beta_{13} \times R_{f,t-1} + qf_{11} \times SENT_{Fl,t} + ma_{10} \times \varepsilon_{s,t-1} + \varepsilon_{s,t} \quad (3)$$

$$R_{ft} = \beta_{20} + \beta_{21} \times ECT_{t-1} + \beta_{22} \times R_{f,t-1} + \beta_{23} \times R_{s,t-1} + qf_{21} \times SENT_{Fl,t} + ma_{20} \times \varepsilon_{f,t-1} + \varepsilon_{f,t} \quad (4)$$

Table IV
Foreign Sentiment Index and Excess Return of Cash-Futures Markets
(Equations (3)-(4))

HAC-Robust Standard Errors are applied. *** and ** represent significance level at 1% and 5%, respectively.

Variable	Coefficient	S.E.	t-stat.	p-value
Panel A. Equation (3)				
<i>Constant_s</i>	-0.9947	0.5864	-1.6963	0.0898*
<i>ECT_{s,t-1}</i>	-0.0880	0.0543	-1.6212	0.1050
<i>R_{s,t-1}</i>	-0.5001	0.0631	-7.9312	0.0000***
<i>R_{f,t-1}</i>	0.3519	0.0704	4.9978	0.0000***
<i>SENT_{Fl,t}</i>	0.5298	0.0374	14.1554	0.0000***
<i>ε_{s,t-1}</i>	0.1647	0.0475	3.4670	0.0005***
Panel B. Equation (4)				
<i>Constant_f</i>	-3.0898	0.6304	-4.9016	0.0000***
<i>ECT_{f,t-1}</i>	-0.2808	0.0580	-4.8390	0.0000***
<i>R_{f,t-1}</i>	-0.0437	0.0800	-0.5461	0.5850
<i>R_{s,t-1}</i>	0.5950	0.0417	14.2679	0.0000***
<i>SENT_{Fl,t}</i>	0.5843	0.0427	13.6703	0.0000***
<i>ε_{f,t-1}</i>	0.2211	0.0388	5.7040	0.0000***

The results show that at the 5% significance level, the error correction term significantly and negatively impacts the excess returns, indicating that when the market is mispriced, the price adjustment occurs mainly in the futures market due to its lower transaction costs. The index of foreign investor sentiment has a significant and positive impact on the excess returns of cash and futures markets, with the estimated values of 0.5298 and 0.5843 respectively, and the *t* statistic (shown in Table IV) shows that the impact on the futures market is relatively high when foreign investor sentiment stays high. This is because the futures market is characterized with a low cost and high leverage compared to the cash market. As for the spillover effect of excess returns, there is a significant spillover effect between the cash and futures markets, and the cash market has its own spillover. In addition, the coefficients of MA(1) variables show a significant positive, indicating that both markets are imperfect.

B.2. Foreign Investor Sentiment and Market Volatility

Table V describes the effect of foreign investor sentiment on volatilities of cash and futures markets. Equations (7) and (8) are restated as follows:

$$h_{s,t} = \exp[vc_{11} + va_{11} \times \ln(h_{s,t-1}) + va_{12} \times \ln(h_{s,t-2}) + vb_{11} \times G_{s,t-1} + vb_{12} \times G_{f,t-1} + d_{10} \times SENT_{FI,t-1}]. \quad (7)$$

$$h_{f,t} = \exp[vc_{22} + va_{22} \times \ln(h_{f,t-1}) + va_{22} \times \ln(h_{f,t-2}) + vb_{21} \times G_{f,t-1} + vb_{22} \times G_{s,t-1} + d_{20} \times SENT_{FI,t-1}]. \quad (8)$$

Table V
Foreign Investor's Sentiment and Volatilities of Cash-Futures Markets (Equations (5)-(8))

HAC-Robust Standard Errors are applied. *** and ** represent significance level at 1% and 5%, respectively.

Variable	Coefficient	S.E.	t-stat.	p-value
Panel A. Equations (5) vs. (7)				
$Constant_s$	-0.0009	0.0028	-0.3231	0.7466
$h_{s,t-1}$	0.9440	0.0756	12.4922	0.0000***
$h_{s,t-2}$	0.0196	0.0714	0.27405	0.7840
$\varepsilon_{s,t}/\sqrt{h_{s,t}}$	0.4471	0.6477	0.6904	0.4899
$G_{s,t-1}$	-0.0471	0.0595	-0.7917	0.4285
$G_{f,t-1}$	0.2052	0.0480	4.27660	0.0000***
$SENT_{FI,t-1}$	-0.0318	0.0089	-3.5859	0.0003***
$Constant_f$	0.0030	0.0023	1.2755	0.2021
Panel B. Equations (6) vs. (8)				
$h_{f,t-1}$	1.0673	0.1365	7.8190	0.0000***
$h_{f,t-2}$	-0.0941	0.1316	-0.7149	0.4746
$\varepsilon_{f,t}/\sqrt{h_{f,t}}$	-0.1796	0.2645	-0.6792	0.4970
$G_{f,t-1}$	0.1608	0.0521	3.0814	0.0021***
$G_{s,t-1}$	-0.0484	0.0538	-0.8989	0.3687
$SENT_{FI,t-1}$	-0.0269	0.0100	-2.6869	0.0072***

The results indicate that at the 5% significance level, there exists an own spillover effect, regardless of the cash or futures market; the sum of corresponding parameters is less than unity, meaning a phenomenon of volatility clustering which will come to stationarity. There is cross-market volatility spillover from the futures to cash markets. In addition, no leverage effect is found for each of two markets.

In terms of sentiment index, it has a significant and negative relationship with the cash and futures market volatility, showing that high foreign investor sentiment will reduce the cash and futures markets' volatility. This is because the

higher the sentiment of foreign investors stays, the more worried they are about facing the risk of the market, thus adjusting their holdings or trading positions, which leads to reduction in the future market volatility. This finding is similar to that of Corredor, Ferrer, and Santamaria (2013).

B.3. Foreign Investor Sentiment and Cross-Market Correlation

Table VI reports the influence of sentiment of foreign investors on the cash-futures market's correlation and Equation (9) is restated as follows:

$$h_{sf,t} = (\rho + d \times SENT_{FI,t}) \times \sqrt{h_{s,t} \times h_{f,t}}. \quad (9)$$

As far as correlation is concerned, the parameter of the sentiment index is positively significant, meaning that the higher the sentiment stays, the greater the interactions between the cash-futures markets. In view of practical operation, when the market is in high sentiment, foreign investors can control or reduce their risk by switching trading strategy from the directional trading to the arbitrage or spread trading, thus enhancing correlation. This finding is consistent with Bohl, Salm, and Wilfling (2011). In addition, high investor sentiment in a market that is dominated by noise-based investors is more likely to have a lower correlation between the cash-futures markets due to information trader exit from the market (Shleifer and Vishny (2003)). This is inconsistent with the empirical findings of this study; that is, trading behavior of foreign investor may be a leading indicator to the retail investors, which thus enhances the cross-market interactions, especially with markets being high sentiment.

Table VI
Impact of Foreign Investor Sentiment on Cash-Futures Market
Correlation (Equation (9))

HAC-Robust Standard Errors are applied. *** and * represent significance level at 1% and 10%, respectively.

Variable	Coefficient	S.E.	t-stat.	p-value
ρ	0.9495	0.0031	310.6243	0.0000***
$SENT_{FI,t}$	0.0040	0.0022	1.8155	0.0694*
Function Value	-2,149.1458			

B.4. Diagnostic Analysis of Model

First, according to the test results of standardized residuals described in Table VII, they indicate that the standardized residuals and squared standardized residuals are serially uncorrelated for both the cash and futures markets. In other words, serial correlation, ARCH, and cross-correlation cannot be found after model is fitted.

Table VII
Diagnosis of Standardized Residuals

Ljung-Box Q test with lag length of 6 (12) is applied. s and f represent the cash and futures markets, respectively. *** and ** represent significance level at 1% and 5%, respectively.

Ljung-Box Test	Q-stat.	p-value
$Q_s(6)$	8.1770	0.2254
$Q_s(12)$	17.5900	0.1287
$Q_f(6)$	4.7250	0.5795
$Q_f(12)$	13.2510	0.3511
$Q_s^2(6)$	2.9690	0.8128
$Q_s^2(12)$	10.8570	0.5413
$Q_f^2(6)$	1.9140	0.9274
$Q_f^2(12)$	7.4200	0.8286
$Q_s(6) \times Q_f(6)$	2.8230	0.8307
$Q_s(12) \times Q_f(12)$	9.5890	0.6520

Table VIII
Diagnosis of Asymmetric Test of Volatility

Engle and Ng (1993) asymmetric test is applied. SN, SNU, and SPU represent negative sign, negative bias size and positive bias size, respectively. The numbers in parenthesis are the estimated parameters. *** and ** represent significance level at 1% and 5%, respectively.

Market	SN	SNU	SPU	F-stat.	p-value
R_s	(0.0124)	(-0.0073)	(-0.1272)	0.9400	0.4205
R_f	(-0.0067)	(-0.0152)	(-0.1015)	0.5710	0.6341

Secondly, as suggested by Engle and Ng (1993), the asymmetric test can be an alternative to the inadequacy of Ljung-Box test. The test result of Table VIII indicates that the null hypothesis of no asymmetric volatility cannot be rejected at the 5% significance level, suggesting that the empirical model can effectively fit the actual data.

Lastly, the impact test of foreign investor sentiment is applied on excess returns, volatility, and correlation; the results, reported in Table IX, suggest the importance of foreign investor sentiment. Moreover, as compared to the cash market, the futures market has more sensitivity to foreign investor sentiment.

Table IX
Impact Test of Foreign Investor Sentiment

*** and ** represent significance level at 1% and 5%, respectively.

Hypothesis	Statistics	p-value
$H_{01}: qf_{11} - qf_{21} = 0$ (Foreign investor sentiment has the same influence on the excess returns of cash and futures markets.)	-5.8558 (t-stat.)	0.0000***
$H_{03}: d_{10} - d_{20} = 0$ (Foreign investor sentiment has the same influence on the volatility of cash and futures markets.)	-1.2600 (t-stat.)	0.2077
$H_{04}: qf_{11} = qf_{21} = 0$ (Foreign investor sentiment has no influence on the excess returns of cash and futures markets.)	205.6440 (Chi-Squared (2))	0.0000***
$H_{05}: d_{10} = d_{20} = 0$ (Foreign investor sentiment has no influence on the volatility of cash and futures markets.)	15.4848 (Chi-Squared (2))	0.0004***
$H_{06}: qf_{11} = qf_{21} = d_{10} = d_{20} = d = 0$ (Foreign investor sentiment has no influence on the excess returns, volatility and correlation of cash and futures markets.)	212.4749 (Chi-Squared (5))	0.0000***

B.5. Robustness Test of Empirical Results

Referring to the Baker and Wurgler (2006) approach, we first regress each sentiment proxy on the macroeconomic variables and obtain the residual terms,⁷ and then employ the PCA to construct the sentiment index of foreign investors that is used to carry out robustness testing. The results shown in Tables X to XII demonstrate that the sentiment index of foreign investors significantly and positively influences the excess returns of cash and futures markets, reduces the volatility of each market and increases the correlation of two markets, in line with the main results of this study. This also indirectly justifies the application value of the variable *MRT0*; that is, when regarding investor sentiment, *MRT0* can be used as the proxy for macroeconomic information. Other findings include excess returns and volatility spillovers, the price adjustment being relatively large in the futures market, and the markets are characterized by imperfections.

⁷ Taiwan's macroeconomic variables include (1) real private consumption expenditure, (2) industrial production index, (3) employment population, and (4) recession indicators. The above data are adjusted with reference base being 2001=100. The data sources are TEJ, Directorate-General of Budget, Accounting and Statistics, the Executive Yuan of R.O.C. (Taiwan), and National Development Council. Unlike Baker and Wurgler (2006) who can detail into durables consumption, non-durables consumption, and services consumption, this study uses only real private consumption expenditure, together with others because of not being able to subcategorize consumption exactly. In addition, the original variable is a monthly frequency data. We first take the first difference of log transformed variables, which indicates a monthly growth rate (except for the recession indicators) and based on the average daily growth rate, then convert into the daily frequency variable in the manner of Baker and Wurgler (2006). It is noted that the orthogonalized individual sentiment proxies are all stationary.

Table X
Foreign Sentiment Index and Excess Return of Cash-Futures Markets
(Equations (3)-(4))

Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
Panel A. Equation (3)				
$Constant_s$	-1.3024	0.2691	-4.8407	0.0000***
$ECT_{s,t-1}$	-0.1188	0.0248	-4.7945	0.0000***
$R_{s,t-1}$	-0.5360	0.0521	-10.2955	0.0000***
$R_{f,t-1}$	0.3521	0.0636	5.5406	0.0000***
$SENT_{FI,t}$	0.5115	0.0367	13.9257	0.0000***
$\varepsilon_{s,t-1}$	0.2074	0.0720	2.8802	0.0040***
Panel B. Equation (4)				
$Constant_f$	-3.4342	0.3784	-9.0745	0.0000***
$ECT_{f,t-1}$	-0.3152	0.0344	-9.1745	0.0077***
$R_{f,t-1}$	-0.0609	0.0862	-0.7066	0.4798
$R_{s,t-1}$	-0.1821	0.0611	-2.9828	0.0029***
$SENT_{FI,t}$	0.5724	0.0406	14.09517	0.0000***
$\varepsilon_{f,t-1}$	0.2565	0.0595	4.3134	0.0000***

Table XI
Foreign Sentiment Index and Volatilities of Cash-Futures Markets
(Equations (5)-(8))

Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
Panel A. Equations (5) vs. (7)				
$Constant_s$	-0.0007	0.0053	-0.1328	0.8944
$h_{s,t-1}$	0.9713	0.0115	84.5172	0.0000***
$\varepsilon_{s,t}/\sqrt{h_{s,t}}$	1.6226	3.0404	0.5337	0.5936
$G_{s,t-1}$	-0.0441	0.0799	-0.5522	0.5808
$G_{f,t-1}$	0.1909	0.0636	3.0031	0.0027***
$SENT_{FI,t-1}$	-0.0285	0.0084	-3.4040	0.0007***
Panel B. Equations (6) vs. (8)				
$Constant_f$	0.0026	0.0044	0.6034	0.5463
$h_{f,t-1}$	0.9756	0.0102	95.7094	0.0000***
$\varepsilon_{f,t}/\sqrt{h_{f,t}}$	0.0591	0.2526	0.2340	0.8150
$G_{f,t-1}$	0.1636	0.0604	2.7082	0.0068***
$G_{s,t-1}$	-0.0411	0.0771	-0.5332	0.5939
$SENT_{FI,t-1}$	-0.0296	0.0083	-3.5498	0.0004***

Table XII
Foreign Sentiment Index and Correlation of Cash-Futures Markets
(Equation (9))

HAC-Robust Standard Error is applied. *** and ** represent significance level at 1% and 5%, respectively.

Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
ρ	0.9490	0.0029	324.9086	0.0000***
$SENT_{FI,t}$	0.0055	0.0025	2.1845	0.0289**
Function Value	-2,151.1571			

Secondly, the empirical results (see Table XIII) of the sub-samples (from March 20, 2009 to February 8, and February 9, 2012 to December 31, 2014) show that sentiment index of foreign investors can increase the excess returns of two markets, reduce the following market volatility, and increase correlation, except for the first sub-sample where no significant increase in excess returns is found. The findings are similar to those of the full sample, at least on the same direction of impact. In addition, other robustness tests are conducted when considering sentiments of the bull and bear markets, the U.S. QE policy periods, stock sales with very huge volumes in 2011, and five individual proxies for sentiment, respectively.⁸

As for both bull and bear markets,⁹ sentiments are found to significantly influence the excess returns of cash and futures markets, respectively (see Table XIV). In addition, the sentiment effect is significantly different between the bull and bear atmosphere in each market (with *t*-statistics of -5.2124 and -5.2735 for cash and futures market, respectively). In other words, when market stays in a bear state, foreign investors could trade in advance to make profit by having well utilized private quality information (Yu and Lai (1999)). Furthermore, sentiment can reduce the future market volatility, regardless of the bull or bear market, but market volatility can be significantly reduced only in a bull market's atmosphere, in line with the main finding of this study.

Regarding the U.S. QE policy (see Table XV), the policy may influence the money supply of foreign investors, among which the operation twist (OT) did not release net money flow to the U.S. financial market and the effect of sentiment

⁸ The empirical models of robustness tests on the long and short periods (Table XIV), the U.S. QE policy (Table XV), and the stock sales with very huge volumes in 2011 (Table XVI) are shown in detail under the corresponding Tables, while the rest are the same as the main model of this study and they are not reported here to save space, but are available upon request.

⁹ To differentiate between a bull market and a bear market, we refer to Dennis and Strickland (2002) and Cooper, Gutierrez, and Hameed (2004) by defining if $\sum_{m=100}^1 r_{t-m} > 0$ (*r* is cash or futures market return), $D_n = 1$, indicating a bull market and zero, otherwise.

Table XIII
Subsample Analysis: Foreign Sentiment Index and Excess Returns, Volatilities, and Correlation of Cash-Futures Markets (Adjustment According to Equations (3), (4), & (7)-(9))

The first sub-sample spans from March 20, 2009 to February 8, 2012 while the second sub-sample spans from February 9, 2012 to December 31, 2014. HAC-Robust Standard Error is applied. *** and ** represent significance level at 1% and 5%, respectively.

	Main Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
Panel A. 1 st Sub-Sample					
(3)	$SENT_{FI,t}$	0.0195	0.0305	0.6406	0.5218
(4)	$SENT_{FI,t}$	0.0365	0.0333	1.0951	0.2735
(7)	$SENT_{FI,t-1}$	-0.0455	0.0024	-18.8782	0.0000***
(8)	$SENT_{FI,t-1}$	-0.0459	0.0016	-27.9845	0.0090***
(9)	ρ	0.9650	0.0029	333.4448	0.0000***
	$SENT_{FI,t}$	0.0009	0.0028	0.3159	0.7521
	Function Value	-1,336.6277			
Panel B. 2 nd Sub-Sample					
(3)	$SENT_{FI,t}$	0.2406	0.0246	9.8011	0.0000***
(4)	$SENT_{FI,t}$	0.2892	0.0232	12.4687	0.0000***
(7)	$SENT_{FI,t-1}$	-0.2288	0.0361	-6.3397	0.0001***
(8)	$SENT_{FI,t-1}$	-0.1974	0.0490	-4.0271	0.0000***
(9)	ρ	0.9532	0.0036	264.3424	0.0000***
	$SENT_{FI,t}$	0.0056	0.0042	1.3366	0.1813
	Function Value	-797.1079			

corresponding to OT period was not performed.¹⁰ Overall, foreign investor sentiment before the QE exit period is positively related to excess return, significantly decreased volatility (e.g., stabilizing market) but increased the interactions of the cash and futures markets. However, sentiment of exit period from QE only significantly reduces the correlation. These findings indicate a significant association of foreign investor sentiment with QE policy, while in the exit period due to the expected gradual decrease in QE, it may lead to slowdown in foreign investors' trading manipulation, the unknown direction of manipulation or other factors and therefore, the influence is different from the period prior to the QE exit.

¹⁰ According to preliminary OLS regression analysis, operation twist period (but some of the period overlaps with QE3) represented by dummy variable, OT, is not related to sentiment with *p*-value of 0.3032 and QE exit period (QEND) seems marginally related to sentiment with *p*-value of 0.1061, while the rest of the periods including QE1, QE2, and QE3 are all significant to sentiment. Thus, this study tests the effect of the sentiment of foreign investors corresponding to QE1, QE2, QE3, and QEND periods.

Table XIV
Influence of Sentiment in Long and Short Market on Excess Return, Volatility, and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), (7), & (8))

$LS_t(SS_t)$ is a dummy variable for a long (short) market. ***, **, and * represent significance level at 1%, 5%, and 10%, respectively. the empirical models are shown as follows:

$$R_{st} = \beta_{10} + \beta_{11} \times ECT_{t-1} + \beta_{12} \times R_{s,t-1} + \beta_{13} \times R_{f,t-1} + qf_{11} \times LS_t \times SENT_{FI,t} + qf_{12} \times SS_t \times SENT_{FI,t} + ma_{10} \times \varepsilon_{s,t-1} + \varepsilon_{s,t}, \quad (3)$$

$$R_{ft} = \beta_{20} + \beta_{21} \times ECT_{t-1} + \beta_{22} \times R_{f,t-1} + \beta_{23} \times R_{s,t-1} + qf_{21} \times LS_t \times SENT_{FI,t} + qf_{22} \times SS_t \times SENT_{FI,t} + ma_{20} \times \varepsilon_{f,t-1} + \varepsilon_{f,t}, \quad (4)$$

$$h_{s,t} = \exp[vc_{11} + va_{11} \times \ln(h_{s,t-1}) + va_{12} \times \ln(h_{s,t-2}) + vb_{11} \times G_{s,t-1}vb_{12} \times G_{f,t-1} + d_{10} \times LS_{t-1} \times SENT_{FI,t-1} + d_{11} \times SS_{t-1} \times SENT_{FI,t-1}], \quad (7)$$

$$h_{f,t} = \exp[vc_{22} + va_{22} \times \ln(h_{f,t-1}) + va_{22} \times \ln(h_{f,t-2}) + vb_{21} \times G_{f,t-1}vb_{22} \times G_{s,t-1} + d_{20} \times LS_{t-1} \times SENT_{FI,t-1} + d_{21} \times SS_{t-1} \times SENT_{FI,t-1}], \quad (8)$$

$$h_{sf,t} = (\rho + d \times SENT_{FI,t}) \times \sqrt{h_{s,t} \times h_{f,t}}. \quad (9)$$

	Main Variable	Coefficient	S.E.	t-stat.	p-value
(3)	$LS_t \times SENT_{FI,t}$	0.5009	0.0322	15.5501	0.0000***
	$SS_t \times SENT_{FI,t}$	0.5710	0.0474	12.0581	0.0000***
(4)	$LS_t \times SENT_{FI,t}$	0.5551	0.0379	14.6507	0.0000***
	$SS_t \times SENT_{FI,t}$	0.6645	0.0529	12.5517	0.0000***
(7)	$LS_t \times SENT_{FI,t-1}$	-0.0558	0.0125	-4.4595	0.0000***
	$SS_t \times SENT_{FI,t-1}$	-0.0027	0.0080	-0.3387	0.7349
(8)	$LS_t \times SENT_{FI,t-1}$	-0.0517	0.0116	-4.4602	0.0000***
	$SS_t \times SENT_{FI,t-1}$	-0.0038	0.0077	-0.4950	0.6206
(9)	ρ	0.9500	0.0029	324.3433	0.0000***
	$SENT_{FI,t}$	0.0043	0.0020	2.1468	0.0318**
	Function Value	-2140.2826			

Because of previously discussed stock sales with very huge volumes in 2011 (refer to Table I), we define that particular period as a short market, a total of 104 days with an average excess return of -0.80% that is less than the average of 0.10% in the other period in cash market.¹¹ Thus, it is worth investigating the influence of foreign investor sentiment in that period. The result of Table XVI shows that sentiment attached to stock sales with very huge volumes in 2011 has made a significant impact on the excess return of cash market relative to the other period, but the impact is reduced. It also reduces the correlation and has

¹¹ When both sentiment of foreign investors < its 25th percentile and observations of sentiment included in the year of 2011, then D2011 equals one, or zero otherwise. There is a total of 104 days when D2011=1, indicating a short (pessimistic) cash market.

no significant effect on volatility of cash-futures markets. Thus, foreign investors in the short market period still use their professional knowledge and thus have good performance.

Table XV

Influence of the US QE on Excess Return, Volatility, and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), & (7)-(9))

$QE1_t$ (March 18, 2009-March 16, 2010), $QE2_t$ (November, 2010-June 30, 2011) $QE3_t$ (September 13, 2012-December 31, 2014), and $QEND_t$ (December 18, 2013-December 31, 2014) represent periods of QE1, QE2, QE3, and exit from QE, respectively. ***, **, and * represent significance level at 1%, 5%, and 10%, respectively. The empirical models are as follows:

$$R_{st} = \beta_{10} + \beta_{11} \times ECT_{t-1} + \beta_{12} \times R_{s,t-1} + \beta_{13} \times R_{f,t-1} + qf_{11} \times LS_t \times SENT_{FI,t} + qf_{12} \times SS_t \times SENT_{FI,t} + ma_{10} \times \varepsilon_{s,t-1} + \varepsilon_{s,t}, \quad (3)$$

$$R_{ft} = \beta_{20} + \beta_{21} \times ECT_{t-1} + \beta_{22} \times R_{f,t-1} + \beta_{23} \times R_{s,t-1} + qf_{21} \times LS_t \times SENT_{FI,t} + qf_{22} \times SS_t \times SENT_{FI,t} + ma_{20} \times \varepsilon_{f,t-1} + \varepsilon_{f,t}, \quad (4)$$

$$h_{s,t} = \exp[vc_{11} + va_{11} \times \ln(h_{s,t-1}) + va_{12} \times \ln(h_{s,t-2}) + vb_{11} \times G_{s,t-1}vb_{12} \times G_{f,t-1} + d_{10} \times LS_{t-1} \times SENT_{FI,t-1} + d_{11} \times SS_{t-1} \times SENT_{FI,t-1}], \quad (7)$$

$$h_{f,t} = \exp[vc_{22} + va_{22} \times \ln(h_{f,t-1}) + va_{22} \times \ln(h_{f,t-2}) + vb_{21} \times G_{f,t-1}vb_{22} \times G_{s,t-1} + d_{20} \times LS_{t-1} \times SENT_{FI,t-1} + d_{21} \times SS_{t-1} \times SENT_{FI,t-1}], \quad (8)$$

$$h_{sf,t} = (\rho + d \times SENT_{FI,t}) \times \sqrt{h_{s,t} \times h_{f,t}}. \quad (9)$$

	Main Variable	Coefficient	S.E.	t-stat.	p-value
(3)	$QE1_t \times SENT_{FI,t}$	0.9871	0.1503	6.5659	0.0000***
	$QE2_t \times SENT_{FI,t}$	0.5143	0.0376	13.6611	0.0000***
	$QE3_t \times SENT_{FI,t}$	0.5507	0.0713	7.7209	0.0000***
	$QEND_t \times SENT_{FI,t}$	0.0054	0.0752	0.0724	0.9423
(4)	$QE1_t \times SENT_{FI,t}$	1.1167	0.1619	6.8989	0.0000***
	$QE2_t \times SENT_{FI,t}$	0.6230	0.0280	22.2537	0.0000***
	$QE3_t \times SENT_{FI,t}$	0.6358	0.0820	7.75097	0.0000***
	$QEND_t \times SENT_{FI,t}$	-0.0937	0.0808	-1.1560	0.2461
(7)	$QE1_t \times SENT_{FI,t-1}$	-0.1509	0.0489	-3.0839	0.0020***
	$QE2_t \times SENT_{FI,t-1}$	-0.1898	0.0425	-4.4644	0.0000***
	$QE3_t \times SENT_{FI,t-1}$	-0.2356	0.0411	-5.7270	0.0000***
	$QEND_t \times SENT_{FI,t}$	0.0535	0.0549	0.9746	0.3298
(8)	$QE1_t \times SENT_{FI,t-1}$	-0.1777	0.0483	-3.6781	0.0002***
	$QE2_t \times SENT_{FI,t-1}$	-0.1627	0.0395	-4.1219	0.0000***
	$QE3_t \times SENT_{FI,t-1}$	-0.2192	0.0422	-5.1901	0.0000***
	$QEND_t \times SENT_{FI,t}$	0.0552	0.0545	1.0128	0.3111
(9)	ρ	0.9586	0.0026	360.0088	0.0000***
	$QE1_t \times SENT_{FI,t}$	-0.0057	0.0035	-1.6414	0.1007
	$QE2_t \times SENT_{FI,t}$	0.0180	0.0063	2.8529	0.0043***
	$QE3_t \times SENT_{FI,t}$	0.0155	0.0082	1.8890	0.0588*
	$QEND_t \times SENT_{FI,t}$	-0.0266	0.0086	-3.1032	0.0019***
	Function Value	-2,061.9686			

Table XVI
Influence of Stock Sales with Very Huge Volumes in 2011 on Excess
Return, Volatility, and Correlation of Cash-Futures Markets
(Adjusted Equations (3), (4), & (7)-(9))

***, **, and * represent significance level at 1%, 5%, and 10%, respectively. The empirical models are as follows:

$$R_{st} = \beta_{10} + \beta_{11} \times ECT_{t-1} + \beta_{12} \times R_{s,t-1} + \beta_{13} \times R_{f,t-1} + qf_{11} \times SENT_{FI,t} + qf_{12} \times D2011_t \times SENT_{FI,t} + ma_{10} \times \varepsilon_{s,t-1} + \varepsilon_{s,t}, \quad (3)$$

$$R_{ft} = \beta_{20} + \beta_{21} \times ECT_{t-1} + \beta_{22} \times R_{f,t-1} + \beta_{23} \times R_{s,t-1} + qf_{21} \times SENT_{FI,t} + qf_{22} \times D2011_t \times SENT_{FI,t} + ma_{20} \times \varepsilon_{f,t-1} + \varepsilon_{f,t}, \quad (4)$$

$$h_{s,t} = \exp[vc_{11} + va_{11} \times \ln(h_{s,t-1}) + va_{12} \times \ln(h_{s,t-2}) + vb_{11} \times G_{s,t-1}vb_{12} \times G_{f,t-1} + d_{10} \times SENT_{FI,t-1} + d_{11} \times D2011_{t-1} \times SENT_{FI,t-1}], \quad (7)$$

$$h_{f,t} = \exp[vc_{22} + va_{22} \times \ln(h_{f,t-1}) + va_{22} \times \ln(h_{f,t-2}) + vb_{21} \times G_{f,t-1}vb_{22} \times G_{s,t-1} + d_{20} \times SENT_{FI,t-1} + d_{21} \times D2011_{t-1} \times SENT_{FI,t-1}], \quad (8)$$

$$h_{sf,t} = (\rho + d10 \times SENT_{FI,t} + d20 \times D2011_t \times SENT_{FI,t}) \times \sqrt{h_{s,t} \times h_{f,t}}. \quad (9)$$

	Main Variable	Coefficient	S.E.	t-stat.	p-value
(3)	$SENT_{FI,t}$	0.4990	0.0395	12.6228	0.0000***
	$D2011_t \times SENT_{FI,t}$	0.4326	0.0992	4.3612	0.0000***
(4)	$SENT_{FI,t}$	0.5629	0.0426	13.2050	0.0000***
	$D2011_t \times SENT_{FI,t}$	0.4522	0.1093	4.1385	0.0000***
(7)	$SENT_{FI,t}$	-0.0239	0.0096	-2.4952	0.0126**
	$D2011_{t-1} \times SENT_{FI,t-1}$	-0.0465	0.0432	-1.0766	0.2817
(8)	$SENT_{FI,t}$	-0.0204	0.0077	-2.63699	0.0084***
	$D2011_{t-1} \times SENT_{FI,t-1}$	-0.0460	0.0363	-1.2685	0.2046
(9)	ρ	0.9456	0.0039	239.7546	0.0000***
	$SENT_{FI,t}$	0.0076	0.0038	1.9908	0.0465**
	$D2011_t \times SENT_{FI,t}$	-0.0106	0.0052	-2.0258	0.0428**
	Function Value	-2,152.5992			

Furthermore, the estimation results of individual sentiment proxies' influence are shown in Tables XVII-XXI, the results show that most individual proxies, similar to sentiment of foreign investor, are influential to excess returns of cash-futures markets. However, the impact sign of *PCR* is different from foreign investor sentiment. The reason is that the *PCR* is negatively related to foreign investor sentiment. Therefore, *PCR* has a negative effect on excess returns and correlation, whereas foreign investor sentiment has a positive effect on them. In addition, both *BSI* and *NPOI* have a significant and negative effect on market volatility.

Table XVII
Influence of Individual Sentiment Proxy (*NIRFI*) on Excess Return, Volatility, and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), & (7)-(9))

***, **, and * represent significance level at 1%, 5%, and 10%, respectively.

	Main Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
(3)	$SENT_{FI,t}$	0.0280	0.0098	2.8607	0.0042***
(4)	$SENT_{FI,t}$	0.0362	0.0113	3.2052	0.0013***
(7)	$SENT_{FI,t-1}$	0.0006	0.0051	0.1269	0.8990
(8)	$SENT_{FI,t-1}$	0.0016	0.0046	0.3372	0.7360
(9)	ρ	0.9585	0.0027	360.3371	0.0000***
	$SENT_{FI,t}$	0.0012	0.0010	1.2366	0.2162
	Function Value	-2,236.1220			

Table XVIII
Influence of Individual Sentiment Proxy (*NTOR*) on Excess Return, Volatility, and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), & (7)-(9))

***, **, and * represent significance level at 1%, 5%, and 10%, respectively.

	Main Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
(3)	$SENT_{FI,t}$	0.1635	0.0665	2.4599	0.0139**
(4)	$SENT_{FI,t}$	0.3883	0.0898	4.3231	0.0000***
(7)	$SENT_{FI,t-1}$	-0.0529	0.0757	-0.6992	0.4845
(8)	$SENT_{FI,t-1}$	-0.0527	0.0733	-0.7191	0.4721
(9)	ρ	0.9583	0.0023	418.2389	0.0000***
	$SENT_{FI,t}$	0.0202	0.0072	2.8061	0.0050***
	Function Value	-2,225.3814			

Table XIX
Influence of Individual Sentiment Proxy (*BSI*) on Excess Return, Volatility, and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), & (7)-(9))

***, **, and * represent significance level at 1%, 5%, and 10%, respectively.

	Main Variable	coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
(3)	$SENT_{FI,t}$	0.4130	0.0348	11.8738	0.0000***
(4)	$SENT_{FI,t}$	0.4526	0.0465	9.7315	0.0000***
(7)	$SENT_{FI,t-1}$	-0.0282	0.0083	-3.4094	0.0007***
(8)	$SENT_{FI,t-1}$	-0.0263	0.0070	-3.7630	0.0002***
(9)	ρ	0.9335	0.0040	230.8285	0.0000***
	$SENT_{FI,t}$	0.0031	0.0015	2.1216	0.0339**
	Function Value	-1,929.8873			

Table XX
Influence of Individual Sentiment Proxy (*PCR*) on Excess Return, Volatility, and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), & (7)-(9))

***, **, and * represent significance level at 1%, 5%, and 10%, respectively.

	Main Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
(3)	$SENT_{FI,t}$	-0.0450	0.0212	-2.1176	0.0342**
(4)	$SENT_{FI,t}$	-0.1241	0.0369	-3.3643	0.0008***
(7)	$SENT_{FI,t-1}$	-0.0052	0.0129	-0.4035	0.6866
(8)	$SENT_{FI,t-1}$	-0.0107	0.0121	-0.8874	0.3749
(9)	ρ	0.9592	0.0023	412.7699	0.0000***
	$SENT_{FI,t}$	-0.0260	0.0092	-2.8355	0.0046**
	Function Value	-2,236.6096			

Table XXI
Influence of Individual Sentiment Proxy (*NPOI*) on Excess Return, Volatility and Correlation of Cash-Futures Markets (Adjusted Equations (3), (4), & (7)-(9))

***, **, and * represent significance level at 1%, 5%, and 10%, respectively.

	Main Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
(3)	$SENT_{FI,t}$	0.2637	0.0315	8.3722	0.0000***
(4)	$SENT_{FI,t}$	0.5506	0.0439	12.5409	0.0000***
(7)	$SENT_{FI,t-1}$	-0.0481	0.0160	-3.0097	0.0026***
(8)	$SENT_{FI,t-1}$	-0.0488	0.0145	-3.3603	0.0008***
(9)	ρ	0.9582	0.0027	348.5769	0.0000***
	$SENT_{FI,t}$	0.0232	0.0075	3.0805	0.0021***
	Function Value	-2,184.0979			

This subsection conducts several robustness tests and most of the results echo “foreign investor sentiment can increase excess returns, decrease volatility and enhance correlation of cash-futures markets.” The exceptions, shown in Table XXII, are *PCR*, stock sales with very huge volumes in 2011, and period exit from QE, all of which decrease interactions of cash-futures markets. The policy implications based on most empirical results are (a) the general investors could follow the foreign investor’s investment strategy, (b) the authorities could consider deregulating to facilitate the expansion of foreign investment in the Taiwan financial market, which may help to stabilize market volatility, and (c) it is recommended to develop financial products related to foreign investor sentiment to facilitate the trading of other investors.

Lastly, Table XXII summarizes all empirical findings that may be linked to price hypothesis. For example, foreign investor sentiment could raise the excess returns through capital momentum due to the increased money supply before QE tapering. Additionally, during the QE period, there is often declaration of significant information that triggers a change in share prices, which can also be linked to the “information effect hypothesis.”

C. Test of Sentiment's Prediction on the Cash Market

The above research is mainly to test the influence of foreign investor sentiment on the cash-futures markets. However, if foreign sentiment can also be used as a tool for general investors to invest in the cash market, foreign sentiment can provide more practical value. Therefore, this study further tests whether the foreign sentiment and its individual proxies can predict the cash market's excess returns in the next period. We thus construct the predictive regression model as shown in Equation (13):

$$R_{t+1} = a + bX_t + \varepsilon_{t+1}, \quad (13)$$

where R_{t+1} is the excess return of cash market in period $t+1$, X_t is foreign sentiment or individual proxies, and ε_{t+1} is the error terms in period $t+1$. We employ the recursive estimation window to produce out-of-sample (OOS) forecast value of cash market's excess returns, and the full sample observation data, R_t and X_t , are divided into the original sample period with 1,081(=m) observations (from March 20, 2009 to July 18, 2013) and out-of-sample period with 362(=s) observations (from July 19, 2013 to December 30, 2014).

Table XXII
Summary of Empirical Findings and the Likely Correspondent Price Hypothesis

BW sample includes sentiment index that is calculated according to Baker and Wurgler (2006). +, -, and . respectively represent the direction of positive impact, negative impact and no impact on variables listed in the first row of Table XXII. pull, press, and info represent price pull hypothesis, price pressure hypothesis, and information effect hypothesis, respectively. Huge sales indicates the foreign investor's huge amount of sales in 2011.

Variable	Excess Return of Cash Market	Excess Return of Futures Market	Volatility of Cash Market	Volatility of Futures Market	Correlation
Full Sample	+(pull, press)	+(pull, press)	-	-	+
BW Sample	+(pull, press)	+(pull, press)	-	-	+
1 st Sub	.	.	-	-	.
2 nd Sub	+(pull, press)	+(pull, press)	-	-	.
Long Market	+(pull)	+(pull)	-	-	+
Short Market	+	+	.	.	+
QE	+(pull, info)	+(pull, info)	-	-	+
QE Tapering	-
NIRFI	+(info)	+(info)	.	.	.
NTOR	+(info)	+(info)	.	.	+
BSI	+(pull, press)	+(pull, press)	-	-	+
PCR	-(info)	-(info)	.	.	-
NPOI	+(info)	+(info)	-	-	+
Huge Sales	+(info)	+(info)	.	.	-

The initial out-of-sample forecast excess return is \hat{R}_{m+1} , which can be expressed as:

$$\hat{R}_{m+1} = \hat{a}_m + \hat{b}_m X_m, \quad (14)$$

where \hat{a}_m and \hat{b}_m are the estimated values of a and b in Equation (13). Then the estimation window starts to gradually expand; that is, each time one observation is increased until the last one of out-of-sample period. Finally, a series of out-of-sample forecast values of excess return are obtained for evaluating the predictive performance with the following out-of-sample R^2 statistic (R_{OS}^2):

$$R_{OS}^2 = 1 - \frac{\sum_{k=1}^S (R_{m+k} - \bar{R}_{m+k})^2}{\sum_{k=1}^S (R_{m+k} - \bar{R}_{m+k})^2}, \quad (15)$$

where \bar{R}_{m+k} is a series of moving average of historical excess returns (e.g., $\bar{R}_{t+1} = \frac{1}{t} \sum_{j=1}^t R_j$) and R_{OS}^2 is proposed by Campbell and Thompson (2008) and used by researchers (e.g., Rapach, Strauss, and Zhou (2010) and Lutzenberger (2014)). If the forecast value of out-of-sample excess returns is better than moving average of historical excess returns, $R_{OS}^2 > 0$. To further test if the R_{OS}^2 is statistically greater than zero, we employ the statistic proposed by Clark and West (2007) as a tool shown in Equation (16):

$$f_{t+1} = (R_{t+1} - \bar{R}_{t+1})^2 - \left[(R_{t+1} - \hat{R}_{t+1})^2 - (\bar{R}_{t+1} - \hat{R}_{t+1})^2 \right]. \quad (16)$$

The f_{t+1} is regressed on a constant term and the corresponding t -statistic is obtained to test the null hypothesis of $R_{OS}^2 \leq 0$. The above is the adjusted statistic based on mean squared prediction error (MSPE-adjusted statistic) suggested in Clark and West (2007). Based on R_{OS}^2 and CW-test, Table XXIII shows that overall, the foreign investor sentiment ($SENT_{FI}$) has good predictive performance in the cash market, a finding similar but not superior to that of *NIRFI*. When sentiments are further differentiated into being high and low, some individual proxies (such as *BSI* and *NPOI*) and foreign investor sentiment ($SENT_{FI}$) provide good out-of-sample prediction performance. Thus, these variables can be regarded as leading indicators of investing cash market; in other words, by carefully observing changes in foreign investor sentiment or its proxy variables and following the investment strategy of foreign investors, we may increase the trading performance in the cash market.

V. Conclusion and Suggestions

The impact of “investor sentiment” on financial markets has attracted the attention of many academic scholars. However, most of the investment sentiment is focused on the general investors, and therefore only a few for institutional investors. This study fills the gap of literature, establishes the foreign investor sentiment in a relatively complete way, and explores its

interactions with excess returns, volatility, and cash-futures market correlation. In addition, the usefulness of *MRTO* variable is also a feature of this article. As far as Taiwan's financial market is concerned, "foreign investment" has an indicator effect on other participants, so it is very meaningful to analyze the impact of "foreign investor sentiment."

Table XXIII
Performance of Out-of-Sample Forecasting

The predictors include $SENT_{FI}$, $NIRFI$, $NTOR$, BSI , PCR , and $NPOI$, which are orthogonal to macroeconomic information. CW-test represents the statistic of Clark and West (2007) and they mention that when $R_{OS}^2 < 0$, the null hypothesis can be rejected. DM-test is the modified Diebold-Mariano test and its null hypothesis is: The MSPE of the historical mean \leq MSPE of the predictive regression model. $R_{OS,HS}^2$ and $R_{OS,LS}^2$ represent the out-of-sample R^2 statistic in high and low sentiment, respectively. ***, **, and * represent significance level at 1%, 5%, and 10%, respectively. † indicates CW-test statistic at least at the 10% significance level, while ‡ indicates DM-test statistic at least at the 10% significance level.

Predictor	$R_{OS}^2(\%)$	CW-test	DM-test	$R_{OS,HS}^2(\%)$	$R_{OS,LS}^2(\%)$
$SENT_{FI}$	0.721	2.343**	0.450	4.982†	6.917†‡
$NIRFI$	1.366	2.572**	1.100	-0.023	2.215
$NTOR$	-2.885	-1.877*	-2.282	-5.940	-1.724
BSI	-0.331	0.878	-0.236	6.476†‡	3.211†‡
PCR	-0.142	-1.537	-1.626	-0.325	0.065
$NPOI$	-0.300	1.732*	-0.164	6.381†‡	7.571†‡

This paper analyzes the impact of "foreign investor sentiment" on the Taiwan stock and futures market's excess returns, their volatilities, and the cross-market interactions. In this paper, we consider the five proxy variables for foreign investor sentiment in the four major markets, including the foreign exchange market, the cash market, the option market, and the futures market. According to Baker and Wurgler (2006), we plug principal component analysis into the five proxy variables for foreign investor sentiment, and then based on Connolly and Stivers (2003), *MRTO* is derived as the proxy variable for macroeconomic information. Finally, we utilize *MRTO* to derive the foreign investor sentiment which is orthogonal to macroeconomic information.

According to the Bivariate EGARCH-X-MA (1) model, the empirical results show that: (i) The sentiment indicator of foreign investor has a positive effect on the excess return of the futures and spot markets. Futures market, compared to the cash market, has greater sensitivity to sentiment, indicating that foreign investors in the futures market may have more trading activities. (ii) It is found that the foreign investor sentiment plays a role of stabilizing the market volatility, which may be related to the strategy of adjusting the holding position by controlling the position risk, thus reducing the market volatility. (iii) It is shown that the sentiment indicators are positively significant to the correlation,

suggesting that the higher the foreign investor sentiment stays, the higher the correlation of the cash-futures markets. (iv) When the bear market atmosphere appears, there is a significant positive impact of sentiment on the excess return of the futures and spot markets. This means that when the market is pessimistic (short), foreign investors will be able to manipulate the trading in advance to profit more. (v) Before the exit from QE policy, foreign investor sentiment increased the excess returns, reduced the volatility, and increased correlation between the cash and futures markets. However, during the exit period, the foreign investor sentiment decreased the interaction of futures-spot markets. (vi) The study on the sub-samples is similar to that of the whole sample; that is, the sign of impact at least stays the same; and the results of the individual proxy variables for sentiment except *PCR* are similar to those of the whole sample. (vii) When foreign investor's huge amount of sales of Taiwan shares happened in 2011, foreign investor sentiment has positive impact on excess returns, but the futures-cash market correlation declines. (viii) Foreign investor sentiment indicators and net inward remittance of foreign investors (*NIRFI*) can provide better forecasting performance in the cash market; in addition, under the high and low sentiment both *BSI* and *NPOI* can produce good predictive performance as well. It is worth mentioning that the majority of the empirical results (other than forecasting performance) of foreign investor can be linked to the "price pressure or pull hypothesis" or "information effect hypothesis."

According to the empirical results of this paper, it is found that foreign investors can play a role of stabilizing market volatility, regardless of the cash or futures markets. Thus, the authorities should accelerate the expansion of foreign investment to facilitate the link of the domestic financial market to the international financial market. This suggestion can also be used as a reference for emerging markets to financial policy liberalization. In addition, the manner in which foreign investor trade in the cash-futures markets in high sentiment period can be used as an investment decision-making basis for domestic institutional investors and general investors.

Finally, some future studies can be recommended as follows: (i) In addition to five individual proxy variables for sentiment used in the current paper, technical analysis indicators can be included to see if explanatory and/or predictive powers can be promoted further. (ii) As compared to foreign investor sentiment, general investor sentiment can be tested regarding the influences on excess returns, volatility, and cash-futures market correlation, as well as the predictive power on excess returns of cash market.

Appendix A

Table AI

Test of Correlation between Market Adjusted Relative Turnover ($MRTO(t, t-1, t+1)$) and Macroeconomic Variables

Macroeconomic variables are stationary according to PP unit root test. The null hypothesis is: correlation coefficient=0, and p -values are shown in parenthesis. ER : Growth rate of exchange rate, ΔTS : Change in term spread, AIR : Annual inflation rate; IR : Inflation rate, $Log(IPI)$: Logarithmic industrial production index, $M1B$: $M1B$ growth rate, $M2$: $M2$ growth rate, GD : Government debt growth rate.

Variable	ER	ΔTS	AIR	IR	$Log(IPI)$	$\Delta UNEM$	$M1B$	$M2$	GD
$MRTO_t$	-0.0945 (0.0003)	0.0473 (0.0737)	-0.0000 (0.9986)	-0.0540 (0.0411)	0.0511 (0.0532)	0.0007 (0.9777)	-0.0370 (0.1615)	-0.0200 (0.4504)	-0.0935 (0.0004)
$MRTO_{t-1}$	0.0364 (0.1683)	0.0342 (0.1963)	0.0017 (0.9482)	-0.0057 (0.8284)	0.0522 (0.0484)	-0.0255 (0.3357)	0.0624 (0.0183)	0.0788 (0.0028)	-0.0224 (0.3976)
$MRTO_{t+1}$	-0.0232 (0.3811)	0.0283 (0.2851)	-0.0001 (0.9976)	-0.0160 (0.5444)	0.0512 (0.0526)	-0.0041 (0.8760)	0.0094 (0.7221)	0.0583 (0.0274)	-0.0116 (0.6607)

Appendix B. Report of Principal Component Analysis (PCA)

Table BI

Eigenvalues and Cumulative Proportion of the First Stage PCA

(Eigenvalues: Sum=10, Average=1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	2.525924	0.386225	0.2526	2.525924	0.2526
2	2.139699	0.687176	0.2140	4.665624	0.4666
3	1.452524	0.104910	0.1453	6.118147	0.6118
4	1.347614	0.517312	0.1348	7.465761	0.7466
5	0.830302	0.176841	0.0830	8.296063	0.8296
6	0.653460	0.155747	0.0653	8.949523	0.8950
7	0.497713	0.068405	0.0498	9.447236	0.9447
8	0.429308	0.348776	0.0429	9.876545	0.9877
9	0.080532	0.037609	0.0081	9.957077	0.9957
10	0.042923	N/A	0.0043	10.00000	1.0000

Table BII
Eigenvectors of the First Stage PCA

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
<i>QFIIINIR(t)</i>	0.228762	0.411476	-0.303863	-0.048208	0.431717	0.003643	0.028211	-0.704589	0.005015	0.006229
<i>QFIIINIR(t-1)</i>	0.220568	0.412163	-0.321772	-0.058547	0.414665	0.018507	-0.024923	0.708188	-2.91E-05	-0.008129
<i>NTOR(t)</i>	0.084879	-0.023534	0.004543	0.698702	0.052573	0.675182	-0.212467	-0.008896	-0.011567	-0.006812
<i>NTOR(t-1)</i>	0.085509	-0.015710	-0.004617	0.699092	0.071195	-0.671471	0.216252	0.021784	0.020670	0.009068
<i>BSI(t)</i>	0.358097	0.299933	-0.051008	0.012898	-0.509006	-0.223537	-0.681470	-0.027976	-0.063012	0.028790
<i>BSI(t-1)</i>	0.347118	0.297473	-0.093873	0.011717	-0.550202	0.205861	0.655016	0.016847	0.087220	-0.005573
<i>PCR(t)</i>	-0.298026	0.474616	0.428098	0.047707	0.020763	0.018202	0.045537	0.011805	-0.191163	0.678865
<i>PCR(t-1)</i>	-0.294604	0.479566	0.424894	0.048678	0.007661	-0.010972	-0.023222	-0.003084	0.193398	-0.679845
<i>NPOI(t)</i>	0.473542	-0.122826	0.468698	-0.083605	0.200553	0.002671	-0.047409	0.013092	0.674514	0.190755
<i>NPOI(t-1)</i>	0.485719	-0.105965	0.457377	-0.073455	0.176976	0.009697	0.091473	0.009165	-0.677437	-0.198676

Table BIII
Ordinary Correlation between Variables in the First Stage PCA

	$QFINIR(t)$	$QFINIR(t-1)$	$NTOR50(t)$	$NTOR50(t-1)$	$BSI(t)$	$BSI(t-1)$	$PCR(t)$	$PCR(t-1)$	$NPOI(t)$	$NPOI(t-1)$
$QFINIR(t)$	1.000000									
$QFINIR(t-1)$	0.570272	1.000000								
$NTOR(t)$	0.001083	-0.004516	1.000000							
$NTOR(t-1)$	0.012579	0.001115	0.361223	1.000000						
$BSI(t)$	0.308555	0.308830	0.024856	0.074047	1.000000					
$BSI(t-1)$	0.310556	0.308742	0.067254	0.024592	0.491686	1.000000				
$PCR(t)$	0.058269	0.058832	-0.035995	-0.040052	-0.021081	-0.010444	1.000000			
$PCR(t-1)$	0.064520	0.058461	-0.040694	-0.033945	0.015114	-0.021277	0.952802	1.000000		
$NPOI(t)$	0.031646	0.016627	0.046295	0.031401	0.240913	0.169863	-0.197485	-0.187914	1.000000	
$NPOI(t-1)$	0.051917	0.031961	0.046312	0.051135	0.232022	0.240537	-0.183645	-0.197487	0.917444	1.000000

Table BIV
Factor Loadings of the First Stage PCA

PC1 is the first component, PC2 is the second, and so on.

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
$QFINIR(t)$	0.3636	0.6019	-0.3662	-0.0560	0.3934	0.0029	0.0199	-0.4617	0.0014	0.0013
$QFINIR(t-1)$	0.3506	0.6029	-0.3878	-0.0680	0.3779	0.0150	-0.0176	0.4640	-8.27E-06	-0.0017
$NTOR(t)$	0.1349	-0.0344	0.0055	0.8111	0.0479	0.5458	-0.1499	-0.0058	-0.0033	-0.0014
$NTOR(t-1)$	0.1359	-0.0230	-0.0056	0.8116	0.0649	-0.5428	0.1526	0.0143	0.0059	0.0019
$BSI(t)$	0.5691	0.4387	-0.0615	0.0150	-0.4638	-0.1807	-0.4808	-0.0183	-0.0179	0.0060
$BSI(t-1)$	0.5517	0.4351	-0.1131	0.0136	-0.5014	0.1664	0.4621	0.0110	0.0248	-0.0012
$PCR(t)$	-0.4737	0.6943	0.5160	0.0554	0.0189	0.0147	0.0321	0.0077	-0.0543	0.1407
$PCR(t-1)$	-0.4682	0.7015	0.5121	0.0565	0.0070	-0.0089	-0.0164	-0.0020	0.0549	-0.1409
$NPOI(t)$	0.7526	-0.1797	0.5649	-0.0971	0.1828	0.0022	-0.0335	0.0086	0.1914	0.0395
$NPOI(t-1)$	0.7720	-0.1550	0.5512	-0.0853	0.1613	0.0078	0.0645	0.0060	-0.1922	-0.0412

Table BV
Eigenvalues and Cumulative Proportion of the Second Stage PCA

(Eigenvalues: Sum=5, Average=1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	1.442046	0.286275	0.2884	1.442046	0.2884
2	1.155771	0.177682	0.2312	2.597817	0.5196
3	0.978089	0.187493	0.1956	3.575906	0.7152
4	0.790596	0.157098	0.1581	4.366502	0.8733
5	0.633498	---	0.1267	5.000000	1.0000

Table BVI
Eigenvectors of the Second Stage PCA

Variable	PC1	PC2	PC3	PC4	PC5
<i>QFIINIR(t)</i>	0.494430	0.507833	-0.062423	-0.456998	0.533761
<i>NTOR(t-1)</i>	0.199031	-0.181211	0.959483	-0.023863	0.079823
<i>BSI(t)</i>	0.651971	0.201486	-0.034708	0.087328	-0.724918
<i>PCR(t)</i>	-0.193145	0.702571	0.181395	0.654050	0.091672
<i>NPOI(t-1)</i>	0.503542	-0.418408	-0.203437	0.595966	0.418112

Table BVII
Ordinary Correlations between Variables Used in the Second Stage PCA

	<i>QFIINIR</i>	<i>NTOR(t-1)</i>	<i>BSI</i>	<i>PCR</i>	<i>NPOI(t-1)</i>
<i>QFIINIR(t)</i>	1.000000				
<i>NTOR(t-1)</i>	0.012579	1.000000			
<i>BSI(t)</i>	0.308555	0.074047	1.000000		
<i>PCR(t)</i>	0.058269	-0.040052	-0.021081	1.000000	
<i>NPOI(t-1)</i>	0.051917	0.051135	0.232022	-0.183645	1.000000

Table BVIII
Factor Loadings of the Second Stage PCA

PC1 is the first component, PC2 is the second, and so on.

Variable	PC1	PC2	PC3	PC4	PC5
<i>QFIINIR(t)</i>	0.59374	0.54596	-0.06173	-0.40634	0.42483
<i>NTOR(t-1)</i>	0.23901	-0.19481	0.94891	-0.02122	0.06353
<i>BSI(t)</i>	0.78292	0.21661	-0.03433	0.07765	-0.57698
<i>PCR(t)</i>	-0.23194	0.75531	0.1794	0.58155	0.07296
<i>NPOI(t-1)</i>	0.60468	-0.44982	-0.2012	0.52991	0.33279

Appendix C. Empirical Result of Foreign Investor Sentiment Based on the Individual Proxies Orthogonal to Macroeconomic Variables (Full Sample Period)

Table CI
**Results of Foreign Investor Sentiment on Excess Returns of Cash and
Futures Markets (Equations (3)-(4))**

S.E. is HAC-robust standard error. *** and ** represent significance level at 1% and 5%, respectively.

Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
Panel A. Equation (3)				
$Constant_s$	-0.8588	0.3054	-2.8125	0.0049***
$ECT_{s,t-1}$	-0.0746	0.0286	-2.6079	0.0091***
$R_{s,t-1}$	-0.4869	0.0526	-9.2626	0.0000***
$R_{f,t-1}$	0.3334	0.0274	12.1555	0.0000***
$SENT_{FI,t}$	0.5142	0.0374	13.7479	0.0000***
$\varepsilon_{s,t-1}$	0.1665	0.0402	4.1386	0.0000***
Panel B. Equation (4)				
$Constant_f$	-2.9703	0.3323	-8.9399	0.0000***
$ECT_{f,t-1}$	-0.2687	0.0310	-8.6718	0.0000***
$R_{f,t-1}$	-0.0714	0.0273	-2.6097	0.0091***
$R_{s,t-1}$	-0.1556	0.0329	-4.7306	0.0000***
$SENT_{FI,t}$	0.5843	0.0427	13.6703	0.0000***
$\varepsilon_{f,t-1}$	0.2320	0.0372	6.2373	0.0000***

Table CII
**Results of Foreign Investor Sentiment on Volatility of Cash and
Futures Markets (Equations (5)-(8))**

S.E. is HAC-robust standard error. *** and ** represent significance level at 1% and 5%, respectively.

Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
Panel A. Equations (5) vs. (7)				
$Constant_s$	0.0051	0.0108	0.4712	0.6375
$h_{s,t-1}$	0.9697	0.0108	89.8364	0.0000***
$h_{s,t-2}$	-0.0047	0.0093	-0.5019	0.6157
$\varepsilon_{s,t}/\sqrt{h_{s,t}}$	0.5667	1.4408	0.3933	0.6941
$G_{s,t-1}$	-0.0434	0.0615	-0.7050	0.4808
$G_{f,t-1}$	0.1933	0.0472	4.0940	0.0000***
$SENT_{FI,t-1}$	-0.0320	0.0092	-3.4817	0.0005***
Panel B. Equations (6) vs. (8)				
$Constant_f$	0.0085	0.0102	0.8304	0.4063
$h_{f,t-1}$	0.9759	0.0131	74.2461	0.0000***
$h_{f,t-2}$	-0.0042	0.0085	-0.4972	0.6191
$\varepsilon_{f,t}/\sqrt{h_{f,t}}$	-0.1873	0.4530	-0.4135	0.6793
$G_{f,t-1}$	0.1694	0.0377	4.4923	0.0000***
$G_{s,t-1}$	-0.0491	0.0487	-1.0083	0.3133
$SENT_{FI,t-1}$	-0.0303	0.0099	-3.0620	0.0022***

Table CIII
Results of Foreign Investor Sentiment on Correlation of Cash and Futures Markets (Equation (9))

S.E. is HAC-robust standard error. *** and ** represent significance level at 1% and 5%, respectively.

Variable	Coefficient	S.E.	<i>t</i> -stat.	<i>p</i> -value
ρ	0.9492	0.0036	261.5101	0.0000***
$SENT_{FI,t}$	0.0044	0.0021	2.0847	0.0371**
Function Value	-2,147.3781			

Table CIV
Diagnostic Analysis of Standardized Residuals

Tests are based on Ljung-Box $Q(6)$ and $Q(12)$. *s* and *f* are the cash and futures market, respectively. ***, **, and * represent significance level at 1%, 5% and 10%, respectively.

	<i>Q</i> -stat.	<i>p</i> -value
$Q_s(6)$	9.7490	0.1356
$Q_s(12)$	19.2410	0.0829*
$Q_f(6)$	5.6850	0.4594
$Q_f(12)$	14.0880	0.2951
$Q_s^2(6)$	2.6040	0.8566
$Q_s^2(12)$	11.0850	0.5216
$Q_f^2(6)$	1.9550	0.9238
$Q_f^2(12)$	7.9920	0.7857
$Q_s(6) \times Q_f(6)$	2.7740	0.8367
$Q_s(12) \times Q_f(12)$	10.2350	0.5954

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外資投資情緒對臺灣期、現貨市場之影響

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摘要

本文運用市場調整的相對周轉率並建立臺灣的「外資情緒指標」，探究其對臺灣期現貨市場之影響。主要發現為外資情緒對市場超額報酬率及期現貨市場相關性有正向影響，但對於市場波動性則有負向效果。再者，外資情緒指標及外資淨匯入金額對現貨市場超額報酬率有良好的預測績效。

關鍵詞：市場調整的相對周轉率、外資情緒指標、期現貨市場相關性

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