Int. Fin. Markets, Inst. and Money 31 (2014) 187–215

Contents lists available at ScienceDirect

Journal of International Financial Markets, Institutions & Money

journal homepage: www.elsevier.com/locate/intfin

Informed trading, trading strategies and the information content of trading volume: Evidence from the Taiwan index options market

Wen-liang G. Hsieh*, Huei-Ru He

Graduate Institute of Finance, National Chiao Tung University, 1001 University Road, Hsinchu City 300, Taiwan, ROC

ARTICLE INFO

Article history:
Received 30 May 2013
Accepted 27 March 2014
Available online 5 April 2014

JEL classification:
G14

Keywords:
Index options
Options volume
Informed trading
Foreign institutional investors
Taiwan

ABSTRACT

This paper examines the predictive ability of index option put-call volume on next-day index movements in the Taiwan market. We find that foreign institutional investors are the most informed traders, with their predictive ability being more apparent in a downward market. When engaging in informed trading, foreign institutional investors tend to use out-of-the-money options to achieve high leverage, along with medium-term options to obtain large delta exposure and low theta risk, whilst also sacrificing liquidity by forgoing the use of short-term options. The predictive ability of foreign institutional investors is found to be significantly enhanced on days with important macroeconomic news, thereby indicating their superior interpretative ability of publicly accessible information. Based upon their long-lived informational advantage, foreign institutional investors will tend to engage in informed trading using limit orders and medium-sized trades in order to camouflage their information.

* Corresponding author. Tel.: +886 35712121.
E-mail addresses: wlh@faculty.nctu.edu.tw (W.-l.G. Hsieh), tina65762003@yahoo.com.tw (H.-R. He).

http://dx.doi.org/10.1016/j.intfin.2014.03.012
1042-4431/

1. Introduction

We set out in this study to examine the information content of trading volume, with the overall aim of identifying the patterns of index options usage in informed trading. The extant literature provides evidence on the informativeness of options trading, with some studies identifying which traders are in possession of private trading information. In the present study, we go one step further to examine the various trading decisions faced by investors who possess superior information, as well as the trading strategies that they choose to adopt. In specific terms, we investigate the contracts in which informed traders tend to trade (in-the-money versus out-of-the-money), the type of orders that they use for their trading activities (market versus limit orders, small versus large orders), the type of information that they are likely to exploit (macro versus micro, global versus domestic) and the market conditions under which they choose to trade.

It has been suggested in several of the prior studies that the options markets attract informed trading essentially because investors can benefit from high leverage (Black, 1975), low transaction costs (Fleming et al., 1996) and the flexibility to engage in a variety of trading strategies that are unavailable to them in the spot market.[1] When investors choose to engage in informed trading within the options markets, the trading process may generate rich information content on future stock prices; indeed, it is well documented that the prices of options play a leading role in price discovery,[2] and that they are even capable of predicting future price movements;[3] thus, our focus in the present study is on the information content of options trading volume.

Easley et al. (1998) asserted that observed transactions play an important role in price discovery, essentially because order flow imbalances can reflect the sign and magnitude of private information. They proposed a model which revealed that under certain circumstances, the signed trading volume of options contained valuable information on future equity prices. Cao et al. (2005) subsequently went on to provide direct evidence of options volume playing a stronger informational role during periods when informed trading was particularly intensive, with their findings revealing that during takeover announcement periods, imbalances in call volume had strong predictive ability on next-day stock returns. Pan and Poteshman (2006) further proposed that the put-call ratio of options trading volume initiated by buyers opening new positions should be taken as an information variable, since the volume ratio was found to predict stock returns for the next five days, with both economic and statistical significance.

Within each of the above studies on the informational content of options trading volume, the tendency has been to focus almost exclusively on equity options, with much less emphasis on index options. As regards options on individual stocks, it is already well recognized that corporate insiders and proprietary firm traders (i.e., those who are often found to possess private firm-specific information), are likely to engage in informed trading (Cornell and Sirri, 1992; Harris, 1993). However, with regard to index options, it is far less clear which classes of trader possess superior information, and indeed, exactly where such information originates from, essentially because it is unlikely that any investor would possess 'private' information at the aggregate market level.

However, Ahn et al. (2008) argued that superior information processing skills and different interpretations of exactly the same public information may well result in information asymmetry. They noted that foreign institutional investors were likely to possess an informational advantage over other types of investors, and indeed, they demonstrated a particularly large adverse selection component in the bid-ask spreads in KOSPI 200 options for those trades that had been initiated by such investors.

Chou and Wang (2009) also identified a clear tendency for stealth trading amongst foreign institutional investors and proprietary firms in the index futures market in Taiwan, a finding which implied that certain classes of traders may well possess informational advantages relating to the aggregate market trend. Nevertheless, given the above factors, all of which provide support for the likelihood of

[1] Options trading strategies unavailable to spot market traders include volatility trading (Ni et al., 2008), spread trading (Chaput and Ederington, 2005) and unlimited short sales (Figlewski and Webb, 1993).

[2] Examples include Fleming et al. (1996), Easley et al. (1998) and Cao et al. (2005).

[3] See Chakravarty et al. (2004), Pan and Poteshman (2006) and Chan et al. (2009).

informed traders using index options, there is surprisingly little direct evidence of information trading in the index options markets.

Kang and Park (2008) reported non-trivial information content for net buying pressure (the difference between the number of trades initiated by buyers and sellers) in KOSPI 200 index options, and went on to suggest that the net buying pressure could be used to predict the next five-minute returns on the index. Chan et al. (2009) also examined options trading behavior in the Taiwan index, using the value of the put-call ratio as an information variable, and found that out-of-the-money options led the stock index by up to 90 min. Furthermore, from an examination of the predictive ability of the put-call open-buy volume ratios on the next-day movements in the Taiwan index, Chang et al. (2009) found significant predictive ability for certain types of options traded by foreign institutional investors.[4]

The empirical evidence provided by the recent studies referred to above therefore seems to suggest that trading volume plays a much more aggressive informational role in index options than had previously been suggested within the earlier studies.[5] The present study can be viewed as an extension of the Chang et al. (2009) study in which evidence was found of predictive power in Taiwan index options amongst foreign institutional investors, particularly with regard to their trading positions in near-the-money and middle-horizon options.

Our primary aim in the present study is to determine whether the information content in the options trading undertaken by foreign institutional investors is dependent upon market liquidity, the direction of the index movements and the impact of macroeconomic information, whilst also exploring the types of orders (market versus limit orders) and order size that are likely to be used by such investors when engaging in their informed trading. A sound understanding of these factors should help us to draw a more complete picture of the informational advantages possessed by foreign institutional investors and the ways in which they profit from their information.

The empirical model adopted for the present study follows the methodology of Pan and Poteshman (2006) in which the predictive ability of options volume was investigated by regressing the next-day index returns on the option put-call volume ratio. We begin by classifying the volume of all options trading attributable to four classes of traders, namely, individual investors, market makers, foreign institutional investors and domestic institutional investors, and then examine the predictive ability of the put-call volume ratio on next-day index returns for each of these classes of traders. Our results clearly indicate that the trading volume provided by foreign institutional investors contains rich information relating to future changes in the index, whereas transactions by other classes of traders are largely found to be uninformative.

This finding is generally consistent with the results reported on the aggressive informational role played by foreign institutional investors in many of the emerging derivative markets. For example, the analysis carried out by Chang et al. (2009) on index options trading in Taiwan showed that trading by foreign institutional investors exhibited significant predictive power on the underlying index returns. Similar findings were also provided by Kang and Park (2008), Ahn et al. (2008) and Lee and Wang (2012) with regard to trading in KOSPI 200 index options.

We also discover stronger predictive power in the trading positions of foreign institutional investors in downward markets vis-à-vis upward markets. This is consistent with the suggestion of Johnson and So (2012) that the short-sales constraints in the equity market tend to hinder transactions based upon bearish information; thus, informed agents will trade in options more frequently on negative signals than positive signals in order to overcome the short-sales restrictions on the underlying asset. Although the above argument presented by Johnson and So (2012) was based upon equity options,

[4] Several other studies have examined informational trading in index options. For example, focusing on the information provided by split orders, Kim and Ryu (2012) demonstrated that such orders submitted by institutional investors generally tended to be more informative, whilst Chang et al. (2013) examined the pre-opening trading of index options and showed that information-motivated traders tended to construct their positions prior to the stock market opening, particularly when they possessed bearish information.

[5] Schlag and Stoll (2005) found that the price impact of options volume on the DAX index was only a temporary phenomenon, thereby implying the presence of a liquidity effect as opposed to an information effect. Pan and Poteshman (2006) also showed that index options trading volume contained no information on future index movements, whereas equity options trading volume had strong information content on future stock price movements.

our study provides evidence of short-sales constraints having a similar effect on informed trading in index options.

Our results further reveal that with improvements in overall options trading activity (as measured by trading volume), the trading positions of foreign institutional investors provide enhanced predictive power. The finding suggests that either informed trading induces volume or that informed traders are camouflaging their information-based trading through greater volume. Further evidence consistent with stealth-trading theory is found when we analyze sub-samples categorized by trade sizes, with medium-sized trades containing richer information content on future changes in the index, as compared to either large- or small-sized trades.

As opposed to trading in the most liquid short-term contracts, foreign institutional investors prefer to exploit their informational advantage using medium-maturity and out-of-the-money options. The decisions made by informed traders with regard to contract selection suggest that such traders are willing to sacrifice liquidity for high leverage, high delta and low theta.

Limit orders submitted by foreign institutional investors are found to have greater predictive ability on the next day index value, relative to market orders. According to Kaniel and Liu (2006), informed traders will tend to choose limit orders if they have a sufficiently long information horizon. Since it is difficult for rival traders to copy such long-lived information, informed traders can execute their trading on such information using limit orders, which means that they are prepared to sacrifice immediacy for a lower price impact. Our findings imply that the superior information possessed by foreign institutional investors in the Taiwan option markets is also long-lived, perhaps derived from their interpretation of publicly available information. Indeed, our further analysis shows that the put-call ratios of foreign institutional investors have better predictive power on the index changes on days with important macroeconomic news announcements, as compared to days with no significant news announcements.

Finally, the predictive ability of foreign institutional investors during 'normal' trading days is found to have totally disappeared during the financial tsunami period, even on those days when important macroeconomic news was announced. Further analysis shows that, although switching to more defensive positions, foreign institutions failed to anticipate the large market downturn thus were unable to synthesize profitable option positions prior to adverse market impacts. Results also indicate that their diminished predictability were less attributable to capital constraints or hedging needs.

The remainder of this paper is organized as follows. An introduction to the trading mechanism for Taiwan index options is provided in Section 2, followed in Section 3 by a description of the data adopted for this study. The predictive regression model used to examine the information content of the options volume ratio is presented in Section 4, followed in Section 5 by the presentation and discussion of our empirical results. Finally, the conclusions drawn from this study are presented in Section 6.

2. Institutional background

We empirically examine the Taiwan index options (TXO) traded on the Taiwan Futures Exchange (TAIFEX) in order to analyze the trading decisions of informed traders. TXO contracts are actively traded on a global scale, and indeed, according to the annual report of the World Federation of Exchanges, of all index options listed worldwide, trading frequency in TXO contracts was ranked as the fourth (fifth) largest in the world in 2007 (2008). The underlying spot index of the TXO is the Taiwan Capitalization Weighted Stock Index (TWI), a value-weighted index comprising of virtually all of the common stocks listed on the Taiwan Stock Exchange (approximately 700 firms).

At least five expiration months are listed on any trading day – including the spot month, the next two calendar months and the next two quarter months (March, June, September and December) – with a wide range of strike prices being available for each contract month.[6] During our sample period, the

[6] During our sample period, the Taiwan Stock index level ranged between 7000 and 9000. Within this range the strike price interval is 100 index points for the spot month and the next two calendar months, whereas it is 200 index points for the additional two quarter months.

notional value of each option was approximately NT$ 400,000 (US$ 16,000), with the smaller contract size attracting a large number of retail traders, who contribute over 50 per cent of all trading volume.

The TAIFEX operates a fully electronic trading system where traders can submit either market or limit orders, with the limit orders also being either marketable or non-marketable. The regular trading hours are from 8:45 a.m. to 1:45 p.m. All orders submitted before 8:45 a.m. are executed by a call method upon market opening, with orders being continuously matched during the regular trading session. Incoming orders are automatically matched against existing limit orders on the opposite side of the book, following strict price and time priority rules.

The Exchange coordinates designated market makers for TXO transactions in order to ensure market liquidity, with all market makers being obligated to offer two-way (bid and ask) quotes upon receipt of a quote inquiry from other market participants. The quote entered into the system by a market maker is a firm order, which will enter the order book to compete with other public orders based upon the same price and time priority rules. A futures proprietary firm can apply to be a market maker, which enjoys discounts on transaction fees if its market-making volume exceeds a certain level. Market makers failing to meet the TAIFEX requirement for liquidity provision will be disqualified.

The TAIFEX discloses quote prices and depths for the best five quotes, as well as the results of each trade executed (including the trade price and volume), with the information being electronically disseminated to the public in real-time. Trading is anonymous in that, both before and after a trade, information on the identity of those submitting orders and their trade counterparties is unavailable to the public. After the market close, the TAIFEX publishes its daily trading summary statistics, including trading volume in individual contracts, the volume of all futures proprietary firms, the put/call volume by trader class and the buy/sell volume by trader class.

3. Data

Tick-by-tick data on TXO options was obtained from the TAIFEX for 372 trading days between 2 January 2007 and 30 June 2008. The dataset includes three files on order submissions, trade executions and market maker quotations. The order submissions file records the date, time, trader ID, a buy/sell indicator, order price, order size and the contract characteristics (strike price, maturity and a call/put indicator) for every submitted order. The trade executions file contains the trade price, volume and a key linking the trade back to the original order for every matched trade.

By matching the order submission and trade execution files, we are able to construct the complete history of every transaction and identify the traders on each side of the transactions. The traders are classified as domestic individual investors, domestic institutional investors, foreign institutional investors or market makers, and are assigned a unique ID. The dataset also indicates whether the transaction involves the opening of a new position or the closure (offsetting) of an existing position.

The detailed classification of the data allows us to aggregate the options volume attributable to the different classes of traders (individual investors, domestic institutional investors, foreign institutional investors and market makers), the characteristics of the contracts (put/call, strike price and maturity), the type of orders (market versus limit orders) and trading positions (buy versus sell, open versus offsetting).

Furthermore, we are able to identify each of the parties in a matched trade without having to rely on the Lee and Ready (1991) algorithm, which helps us to clearly distinguish between the motives behind each transaction. This is extremely useful for our examination of the ways in which the information is impounded into security prices through selection of timing, contract, order, trading position and trading strategy by the various classes of traders.[7]

Since the present study focuses on the predictive ability of directional trades, those transactions involving multiple positions (such as spread, straddle and strangle trades, all of which are largely non-directional in nature) are excluded from our sample. The TAIFEX dataset distinguishes between

[7] The data is collected, processed and disseminated electronically by the TAIFEX. The same dataset was also employed by Chang et al. (2009), Han et al. (2009) and Chou and Wang (2009) to examine various issues in options/futures trading on the Taiwan index derivatives markets.

Table 1
Options volume, by different classes of traders and trading positions.

Variables	Foreign institutions	Market makers	Domestic institutions	Individual investors
Panel A: overall distribution by trader classes				
	8.20	34.19	4.44	53.16
Panel B: distribution by call/put and buy/sell				
Buy call	30.75	26.33	24.65	29.56
Sell call	19.81	27.41	25.56	28.33
Buy put	30.44	23.01	25.66	20.66
Sell put	19.00	23.24	24.13	21.45
Panel C: distribution by open/close and buy/sell				
Open buy	55.62	21.82	24.69	33.48
Open sell	26.06	23.20	26.80	17.97
Close buy	5.57	27.53	25.62	16.74
Close sell	12.75	27.45	22.89	31.81

This table reports the details of volume distribution within the four classes of traders between 2 January 2007 and 30 June 2008. The distribution in Panel A is calculated by dividing the total trading volume for each trader class (in number of contracts) by the volume for the overall market, whilst the distributions in Panels B and C are calculated by dividing the volume for each category by the volume of the corresponding class of traders.

plain-vanilla option trades and four types of combination trades, comprising of straddle, strangle, money spread and calendar spread trades. These combination trades, which account for less than 2 per cent of the total trading records, are duly excluded from our analysis.

A summary of trading volume, by trader classes, buy/sell transactions, put/call options and newly opened positions versus the closure of existing positions, is provided in Table 1, with Panel A reporting the daily trading volume (in percentage terms) across the four classes of traders and the time-series averages over 367 trading days. As we can see from this table, trading volume differs significantly across the four classes of traders, with individual investors being the major participants in the TXO market, accounting for 53.16 per cent of the total volume.

Market makers are the second largest trader class, accounting for 34.19 per cent, whilst foreign institutional investors and domestic institutional investors are the least active traders, respectively accounting for only 8.20 per cent and 4.44 per cent. The presence of such large numbers of uninformed retail traders provides opportunities for other more sophisticated traders to exploit their informational advantage.

All transactions within each class of traders are further broken down, in Panel B of Table 1, into buy-call, sell-call, buy-put and sell-put transactions, with the proportions summing vertically to unity within each trader class. We find that foreign institutional investors hold substantially larger positions in long calls (30 per cent) than short calls (20 per cent), whereas the long- versus short-call volume is found to be evenly distributed for other classes of traders. A similar imbalance is also discernible in long put versus short put volume for foreign institutional investors, but not for the other three classes of traders.

Since long calls (long puts) enjoy greater potential profits than short puts (short calls) when the underlying index moves upward (downward), long positions are generally deemed to be the more aggressive positions (Pan and Poteshman, 2006).[8] The substantially larger long option volume in the trading accounts of foreign institutional investors indicates that these traders tend to be more aggressive than other traders, in terms of directional trading.[9]

[8] Pan and Poteshman (2006) noted that the predictive ability of option open-buy volume was found to be better than that of open-sell volume, and indeed, they suggested that information trading was likely to be implemented using long calls or puts, rather than short puts or calls. This is essentially because the worst-case scenario in buying an option is the loss of the option premium, whereas the upside gain can be quite substantial if the private information turns out to be correct. Conversely, the best-case scenario of selling an option is retaining the option premium, whereas the downside loss can be quite substantial if the private signal turns out to be incorrect.

[9] We will examine in later sections whether the aggressive trading of foreign institutional investors is based upon their possession of superior information.

Details of the volume distribution for each of the four classes of traders in open-buy, open-sell, close-buy and close-sell transactions are provided in Panel C of Table 1. Of the four types of transactions, the most likely to be pursued by traders in possession of superior information on future price movements would presumably be open-buy transactions, since open trades are often used to establish new positions for speculating purposes in response to new information within the market. Conversely, close trades (including both close-buy and close-sell) are regarded as being less aggressive, essentially because traders may execute such transactions as a means of realizing their gains or accepting their losses.

Open trades therefore contain more information than close trades, and when engaging in open trades, buying options provides higher potential profits than selling options; therefore, traders who aggressively trade on their informational advantage would tend to initiate more long positions in order to maximize their speculative gains. Taking all of these factors together, since open-buy transactions may well be used for informed trading, they are likely to have much richer information content than other types of transactions (Pan and Poteshman, 2006).

As shown in Panel C of Table 1, foreign institutional investors devote 55.62 per cent of their trading volume to open-buy transactions, a significantly greater proportion than that of any of the other three classes of traders. This substantially larger proportion of open-buy trading indicates that foreign institutional investors are likely to possess superior information and aggressively use open-buy option transactions in order to realize their informational advantage.[10]

4. Methodology

The information content of options is assessed throughout this study by the predictive ability of option volume on future index returns, with our empirical model following the specifications of Pan and Poteshman (2006) to regress the next-day spot market return against the option put-call volume ratio. The option put-call volume ratio, which represents the information possessed by option traders on future changes in the direction of the index, is defined in this study as the open-buy put trading volume (in number of contracts) divided by the sum of open-buy put and open-buy call volume.

Chang et al. (2009) subsequently went on to suggest that the put-call ratio could be used to examine whether a particular class of traders possessed superior information over other market participants, with the calculation being based upon transactions from a subset of trader classes. Our basic regression model follows this suggestion to regress the next-day stock index returns on the put-call volume ratios calculated for each of the four classes of traders shown in Table 1.

The basic model used throughout this study is as follows:

$$R_{t+1} = \alpha_i + \beta_{i,up} X_{i,t} \times D_t + \beta_{i,down} X_{i,t} \times (1 - D_t) + \varepsilon_{i,t} \tag{1}$$

$$D_t = \begin{cases} 1, & R_t > 0; \\ 0, & \text{otherwise} \end{cases}$$

where R_{t+1} is the daily close-to-close return on the TWI spot index at date $t+1$, which we convert into basis points before performing the regressions; $X_{i,t}$ is the information variable proxied by the open-buy put-call volume ratios (calculated from the transactions of trader class i at date t); and D_t is a dummy variable which is equal to 1 if the contemporaneous (day t) market return is positive; otherwise 0.

[10] When examining Panel C of Table 1, we may expect the open-buy (open-sell) volume being equal to the close-sell (close-buy) volume; however, a number of practical issues interfere with the equality relationship. Firstly, the close-sell volume of market markers is more than their open-buy volume, essentially because during our sample period some market makers were disqualified whilst others were newly-licensed, which alters the identity of the traders and makes it difficult to precisely match the open-buy and close-sell volume within any particular trader type. Secondly, the close-sell volume could be smaller than the open-buy volume when some open-buy contracts are held to expiration and settled for cash; in such cases, there will not be a corresponding close-sell transaction for an open-buy position. The same explanation applies to the smaller close-buy volume than open-sell volume.

The information variable $X_{i,t}$ is defined as:

$$X_{i,t} = \frac{P_{i,t}}{P_{i,t} + C_{i,t}} \tag{2}$$

where $P_{i,t}$ and $C_{i,t}$ are the respective numbers of contracts for the open-buy put and call trades of investor class i at date t. If the open-buy volume of a particular class of traders predicts the subsequent movements in the index, then we would expect to observe significantly negative β coefficients.

Figlewski and Webb (1993) and Danielsen and Sorescu (2001) suggested that the short-sales constraints in the stock market result in investors trading in derivatives in response to bad news. If this is the case, then options would be more informative on a day when there was a decline in the market (when spot trading is more subject to short-sales constraints), as compared to a day when there is an increase in the market (when fewer stocks are hindered by short-sales constraints). We include an indicative variable (D_t) to separate the up and down market days, and allow this variable to interact with the put-call ratios. A negatively significant $\beta_{i,up}$ ($\beta_{i,down}$) would indicate a tendency for informed trading to be taking place in an upward (downward) market.[11]

The basic model calculates the volume ratio using only open-buy volume, because we expect to find that the open-buy volume will be more informative than the other three types of volume. The basic model is expanded in Eq. (3) by including additional three volume ratios for open-sell, close-buy and close-sell volume, with the volume ratios being defined in accordance with Eq. (2). All of these volume ratios are set to interact with the upward/downward dummy variable.

This alternative regression model is specified as:

$$\begin{aligned} R_{t+1} = {} & \alpha_i + [\beta^{OB}_{i,up} X^{OB}_{i,t} + \beta^{OS}_{i,up} X^{OS}_{i,t} + \beta^{CB}_{i,up} X^{CB}_{i,t} + \beta^{CS}_{i,up} X^{CS}_{i,t}] \times D_t + [\beta^{OB}_{i,down} X^{OB}_{i,t} + \beta^{OS}_{i,down} X^{OS}_{i,t} \\ & + \beta^{CB}_{i,down} X^{CB}_{i,t} + \beta^{CS}_{i,down} X^{CS}_{i,t}] \times (1 - D_t) + \varepsilon_{i,t} \end{aligned} \tag{3}$$

$$D_t = \begin{cases} 1, & R_t > 0; \\ 0, & \text{otherwise} \end{cases}$$

where $X^{OB}_{i,t}$, $X^{OS}_{i,t}$, $X^{CB}_{i,t}$ and $X^{CS}_{i,t}$ respectively refer to the open-buy, open-sell, close- buy and close-sell put-call ratios.

Speculating on an upward movement in the index, informed traders would tend to purchase calls (open-buy calls), sell puts (open-sell puts), close existing short call positions (close-buy calls) or close existing long put positions (close-sell puts). The result of their trading would be to raise X^{OS} and X^{CS}, whilst depressing X^{OB} and X^{CB}. Similarly, traders who have expectations of a decline in the index would tend to sell calls (open-sell calls), buy puts (open-buy puts), close existing long call positions (close-sell calls) or close existing short put positions (close-buy puts). The end result of their trading would be to lower X^{OS} and X^{CS}, whilst raising X^{OB} and X^{CB}. If certain classes of traders were to consistently make correct predictions, we would then observe a negative coefficient on both β^{OB} and β^{CB}, and a positive coefficient on both β^{OS} and β^{CS}, as the information variables reflecting their open-buy, close-buy, open-sell and close-sell transactions.

[11] It should be noted that our definition of up/down markets, which is dependent on the index return at day t, differs from the conventional identification of bull/bear markets, based on returns over a longer period of time. Our model is designed to examine the effect of short-sales constraints on informed trading in the options market; to achieve this aim, the overall effect of short-sales constraints can be more precisely identified by defining up/down markets based on the index return at day t, as opposed to returns over a longer period. The same definition was adopted by Chen and Rhee (2010) to identify the role of short sales on the information efficiency of stocks in up versus down markets and Hameed et al. (2010), who modeled the effect of market returns on the bid-ask spread, conditional on the direction of the index movement on day t.

5. Empirical results

5.1. Identifying informed traders

The predictive regression results of Eqs. (1) and (3) for each class of traders are presented in Table 2, with the first and second column respectively reporting the coefficient variables and their expected signs (− or +) if the put-call volume ratio correctly predicts the next day index return. The numbers shown in bold text indicate that the coefficients are statistically significant and that their signs support the predictive ability of the put-call ratio.

Several important findings are highlighted, as follows. Firstly, of the four different classes of investors, the option trading positions of foreign institutional investors appear to provide the most accurate forecasting of the next-day spot index, as their open-buy volume ratio is found to be negatively associated with the next-day index return in Eq. (3), with statistical significance at the 1 per cent level. This indicates a tendency for a rise in the next-day index as foreign institutional investors increase their open-buy calls relative to open-buy puts, and vice versa. The close-sell ratio of foreign institutional investors also correctly predicts the next-day index return, albeit with marginal significance.

As regards Eq. (1), where only the open-buy volume ratio is included, of the four classes of traders, only the open-buy positions of foreign institutional investors are found to have any significant correlation with next-day index returns. Furthermore, the predictive regression for foreign institutional investors is found to yield the highest R^2 levels amongst all of the regressions under the same model, which thereby suggests that the volume ratios of foreign institutional investors are capable of explaining a greater proportion of the variation in the next-day returns than the volume ratios of all other types of traders.[12]

Secondly, the predictive ability of the volume ratios of foreign institutional investors is found to prevail only in a downward market but completely absent in an upward market. Panel A of Table 2 shows that the coefficient on the open-buy volume in a downward market (β^{OB}_{down}) is negative and statistically significant, whereas the coefficient in an upward market (β^{OB}_{up}) is insignificant. Such asymmetry in predictive ability is consistent with analyses reported in the prior studies and may well reflect the effect of short-sales constraints in the Taiwan spot market.[13]

For example, from their examination of *equity* options, Danielsen and Sorescu (2001) demonstrated that the short-sales constraints imposed on the spot market may well result in traders with superior information being forced to trade on their information in the equity options markets. Our evidence further indicates that the restrictions on short-selling stocks could also result in stronger demand for *index* options in a downward market, essentially for the purpose of hedging against the downside risk and speculating on an upcoming decline. As informed traders rush to open hedging or speculative positions in index options, their option volume ratios become more informative.

We carry out the tests for the following two implications in order to further investigate the short-sales hypothesis. If the value of the information relating to the option is enhanced with stricter spot short-sales restrictions, then: (i) the predictive ability of the option volume ratio should be more pronounced when the return at $t+1$ is negative than when it is positive; and (ii) the predictive ability should have been weakened after 12 November 2007, when the Taiwan Stock Exchange lifted the 'up-tick' rule for around 150 liquid stocks. The results of these two tests on the open-buy volume ratio of foreign institutional investors are presented in Table 3.[14]

[12] The predictive regressions usually yield low R^2 values. The R^2 values in the present study are comparable to those of Chang et al. (2009), who reported R^2 ranging from 0.0016 to 0.0087 for similar predictive regressions of index returns on put-call ratios.

[13] The short-sales constraints within the Taiwan stock market comprise of: (i) the limited availability of shares to borrow; (ii) a margin requirement of above 110% of the share price; (iii) the requirement for short sellers to cover their short positions during a window surrounding ex-dividend days; and (iv) the 'up-tick' rule whereby a stock is temporarily banned from short-sales transactions when the current stock price has fallen below the closing price on the previous trading day. Although the 'up-tick' rule was lifted for around 150 of the most liquid stocks after 12 November 2007, it remained in place for all other stocks.

[14] We are grateful to an anonymous referee for suggesting the tests for the short-sales hypothesis.

The overall sample is divided into two sub-samples in Panel A, with the first of these sub-samples comprising of cases (days) for which $R_{t+1} > 0$, and the second comprising of cases (days) for which $R_{t+1} \leq 0$. The results of our regressions are found to be consistent with the short-sales hypothesis, that the predictive ability of options will be higher in those cases where the index return at $t+1$ is negative, as compared to when it is positive. The β_{down} coefficient is found to be significantly negative for the $R_{t+1} \leq 0$ sub-sample (with predictive ability) whereas no statistical significance is found in this coefficient for the $R_{t+1} > 0$ subsample.[15]

In Panel B of Table 3, the sample is divided into two sub-periods, pre- and post-12 November 2007, when the Taiwan Stock Exchange relaxed the up-tick rule for around 150 liquid stocks. We allow the independent variable to interact with an indicative variable, *S*, which is equal to 1 if the observation occurs prior to 12 November 2007, otherwise 0. The results lend further support to the short-sales hypothesis, with the only significant coefficient with a correct predictive sign being β_{down}^{Before}, the coefficient for the volume ratio prior to the relaxation of the up-tick rule for observations on a down market day. After easing the short-sales constraints, the predictive ability of options on a down market day, as shown by β_{down}^{After}, is found to be statistically insignificant, albeit with the correct sign.

Our findings are consistent with a number of the prior studies where the asymmetric information efficiency in up versus down markets is attributed to short-sales constraints or short selling. For example, Chan et al. (2009) identified an enhanced leading role of options over the equity index during downward trend periods, whilst Lee and Wang (2012) documented a strong informational role in the short-selling activities of foreign institutional investors within the Korean stock market. Saffi and Sigurdsson (2011) also reported lower price efficiency for those stocks that were subject to higher short-sales constraints.

Our third important finding is that the positions of market makers can hardly be classified as outcomes of informed trading. In Panel B of Table 2, most of the coefficients are found to have the opposite sign to that specified in the first column. Even worse, market makers' open-buy and open-sell ratios exhibit a significant shift in the wrong direction in the case of downward index movements. This finding may look quite odd at first glance, given that market-making firms in Taiwan are operated by professionals with expertise and experience in options trading; however, it may be reconciled by recognizing the primary role of market makers as liquidity providers. Whilst providing liquidity to potential informed traders, these market makers are essentially leaning against the wind. As a consequence, the opposite and significant regression coefficients merely reflect the fact that they are indeed fulfilling their obligation by taking up positions on the opposite side of informed trading.[16]

Fourthly, neither domestic institutional investors nor retail investors are well informed when trading in index options; indeed, the open-buy volume of domestic institutional investors in a downward market has a negative coefficient and a *p*-value of 0.0935 for regression Model (3). Aside from this marginal predictive ability, trading by domestic institutional investors in an upward market appears to result in short-term losses, since their β_{up}^{OS}, β_{up}^{CB} and β_{up}^{CS} coefficients exhibit opposite signs to our expectations. It should be noted that the definition of 'domestic institutional investors' provided by the TAIFEX includes mutual funds, banks and corporations, whilst excluding futures proprietary firms (primarily categorized as market makers). Since trading in options by these market participants is largely for hedging purposes, their positions should be relatively uninformative.

As regards individual traders, all of the coefficients in the two regressions are found to be insignificant, despite some signs being consistent with the next-day index returns. This finding is similar to those reported in several of the prior studies in which it is noted that given their disadvantages in

[15] We also examine an alternative model, where the dummy variable D_t (the positive/negative indicator of the index return on day *t*) in Eq. (1) is replaced by D_{t+1} (the positive/negative indicator of the index return on day $t+1$). The coefficient of β_{down} is found to be significantly negative (−210.61, *p*-value <0.0001), whereas the coefficient of β_{up} is found to be positive (126.43, *p*-value <0.0001). These results provide support for the short-sales hypothesis, that the predictive ability of options will tend to be higher when the index return on day $t+1$ is negative as compared to when it is positive. This model may, however, suffer from the problem of endogeneity, since R_{t+1} appears on both sides of the equation; therefore, this result is not tabulated.

[16] The result here should not be taken as evidence that market makers incur short-term losses. In order to assess the net trading profits/losses of any market makers, we need to take into account the compensation that market makers receive from the bid-ask spread.

Table 2
Predictive ability of option put-call volume ratios.

Variables	Expected sign if with predictive ability	Eq. (3)		Eq. (1)	
		Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: foreign institutions					
Intercept		31.22	0.3682	28.96	0.1766
β_{up}^{OB}	–	−22.50	0.7230	−48.48	0.2517
β_{up}^{OS}	+	−112.53	0.1213	–	–
β_{up}^{CB}	–	−14.23	0.7110	–	–
β_{up}^{CS}	+	43.98	0.2985	–	–
β_{down}^{OB}	–	**−176.63*****	0.0097	**−64.23***	0.0833
β_{down}^{OS}	+	1.48	0.9844	–	–
β_{down}^{CB}	–	39.28	0.3922	–	–
β_{down}^{CS}	+	**76.32***	0.0836	–	–
R^2		0.0401		0.0085	
Panel B: market makers					
Intercept		−13.14	0.8030	−45.77	0.1987
β_{up}^{OB}	–	113.32	0.3518	106.50	0.1865
β_{up}^{OS}	+	−19.25	0.8789	–	–
β_{up}^{CB}	–	−50.29	0.7250	–	–
β_{up}^{CS}	+	−3.09	0.9825	–	–
β_{down}^{OB}	–	249.48*	0.0749	83.70	0.2455
β_{down}^{OS}	+	−283.92*	0.0770	–	–
β_{down}^{CB}	–	177.06	0.3341	–	–
β_{down}^{CS}	+	−150.54	0.3355	–	–
R^2		0.0165		0.0048	
Panel C: domestic institutions					
Intercept		35.74	0.4334	18.16	0.5558
β_{up}^{OB}	–	40.81	0.5395	−29.14	0.6042
β_{up}^{OS}	+	−169.07*	0.0790	–	–
β_{up}^{CB}	–	182.79**	0.0430	–	–
β_{up}^{CS}	+	−124.44*	0.0638	–	–
β_{down}^{OB}	–	**−123.50***	0.0935	−39.09	0.4411
β_{down}^{OS}	+	61.67	0.5272	–	–
β_{down}^{CB}	–	30.37	0.7389	–	–
β_{down}^{CS}	+	−2.33	0.9739	–	–
R^2		0.0284		0.0020	
Panel D: individual investors					
Intercept		35.35	0.6645	−15.62	0.7083
β_{up}^{OB}	–	156.90	0.3281	43.83	0.6740
β_{up}^{OS}	+	−3.68	0.9787	–	–
β_{up}^{CB}	–	−157.54	0.3059	–	–
β_{up}^{CS}	+	−48.00	0.7738	–	–
β_{down}^{OB}	–	−93.51	0.6308	28.26	0.8046
β_{down}^{OS}	+	33.17	0.8307	–	–
β_{down}^{CB}	–	−78.98	0.6693	–	–
β_{down}^{CS}	+	35.37	0.8067	–	–
R^2		0.0064		0.0010	

This table reports the results of the following predictive regressions for each of the four classes of investors.

$$R_{t+1} = \alpha_i + \beta_{i,up} X_{i,t} \times D_t + \beta_{i,down} X_{i,t} \times (1 - D_t) + \varepsilon_{i,t} \tag{1}$$

$$R_{t+1} = \alpha_i + \left[\beta_{i,up}^{OB} X_{i,t}^{OB} + \beta_{i,up}^{OS} X_{i,t}^{OS} + \beta_{i,up}^{CB} X_{i,t}^{CB} + \beta_{i,up}^{CS} X_{i,t}^{CS}\right] \times D_t + \left[\beta_{i,down}^{OB} X_{i,t}^{OB} + \beta_{i,down}^{OS} X_{i,t}^{OS} + \beta_{i,down}^{CB} X_{i,t}^{CB} + \beta_{i,down}^{CS} X_{i,t}^{CS}\right] \times (1 - D_t) + \varepsilon_{i,t} \tag{3}$$

where R_{t+1} is the daily close-to-close spot index return on day $t+1$; $X_S(X_{i,t} = P_{i,t}/(P_{i,t} + C_{i,t}))$ are the put-call volume ratios calculated using open-buy (*OB*) and open-sell (*OS*) volume, and close-buy (*CB*) and close-sell (*CS*) volume; and *D* is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The signs of the coefficients supporting the predictive ability of the volume ratio are indicated by a plus (+) or a minus (−) in the first column. Bold numbers indicate coefficients with correct predictive signs and statistical significance.

* Indicates statistical significance at the 10% level.
** Indicates statistical significance at the 5% level.
*** Indicates statistical significance at the 1% level.

Table 3
Influence of short-sales restrictions on the predictive ability of foreign institutional investors.

Variables	Coefficient	*p*-Value
Panel A: predictive ability conditional on return direction on day $t+1$		
a. Subsample $R_{t+1} > 0$ (169 observations)		
Intercept	123.06***	<0.0001
β_{up}	36.71	0.4778
β_{down}	−10.17	0.8164
Intercept	−117.89***	<0.0001
R^2	0.0131	
b. Subsample $R_{t+1} \leq 0$ (198 observations)		
β_{up}	−46.63	0.1458
β_{down}	**−73.09***	0.0811
Intercept	34.59	0.1137
R^2	0.0112	
Panel B: predictive ability conditional on sub-periods before and after stricter short-sales restrictions		
β_{up}^{Before}	−78.78	0.1527
β_{down}^{Before}	**−102.01****	0.0266
β_{up}^{After}	−48.57	0.2607
β_{down}^{After}	−54.54	0.1601
R^2	0.0143	

Panel A reports the results on the predictive ability of foreign institutional investors, on two sub-samples comprising of cases where $R_{t+1} > 0$ and where $R_{t+1} \leq 0$, based upon the following predictive regression:

$$R_{t+1} = \alpha + \beta_{up} X_t \times D_t + \beta_{down} X_t \times (1 - D_t) + \varepsilon_t,$$

where R_{t+1} is the daily close-to-close spot index return on day $t+1$; $X_t = (P_t/(P_t + C_t))$ is the put-call volume ratio calculated using open-buy (OB) volume of foreign institutional investors; and D_t is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. Coefficients with a negative sign are consistent with the predictive ability of foreign institutional investors. Bold numbers indicate coefficients with correct predictive signs and statistical significance.
Panel B reports the results conditional on the two sub-periods subject to different short-sales restrictions, based upon the following predictive regression:

$$R_{t+1} = \alpha + \left[\beta_{up}^{Before} X_t \times D_t + \beta_{down}^{Before} X_t \times (1 - D_t)\right] \times S_t + \left[\beta_{up}^{After} X_t \times D_t + \beta_{down}^{After} X_t \times (1 - D_t)\right] \times (1 - S_t) + \varepsilon_t,$$

where D_t is an indicative variable which is equal to 1 if $R_t > 0$, otherwise 0; S_t is an indicative variable which is equal to 1 if the observation occurred prior to 12 November 2007 (the date on which the Taiwan Stock Exchange eased the up-tick rule for around 150 liquid stocks), otherwise 0. All other variables are as defined previously.

* Indicates statistical significance at the 10% level.
** Indicates statistical significance at the 5% level.
*** Indicates statistical significance at the 1% level.

trading against professionals (in terms of capital, expertise and research resources), individual investors contribute little to price discovery or the disclosure of information on futures (Frino et al., 2004; Chou and Wang, 2009), options (Ahn et al., 2008; Han et al., 2009) or spot equities (Grinblatt and Keloharju, 2000; Barber et al., 2009).

The Eqs. (1) and (3) regression results indicate that the open-buy ratio is more informative than the other three volume ratios, which is consistent with the suggestion of Pan and Poteshman (2006) that an open-buy strategy represents a more aggressive strategy when traders have strong views on future price movements, thereby revealing richer information content than open-sell, close-buy and close-sell strategies. Our subsequent analysis therefore focuses entirely on the predictive ability of the open-buy volume ratio.

Our regression results using Eq. (1) show a decline of 64.23 basis points in the next-day index following a one unit increase (from 0 to 1) in the open-buy put-call ratio of foreign institutional investors. Translating this into a more plausible variation in the put-call ratio, a one standard deviation (21 per cent) change in the put-call ratio is associated with a −13.48 basis point change in the index (64.23 × 0.21). Given an average index level of around 8476 and a median daily absolute index

Table 4
Predictive ability of the open-buy ratio conditional on option market activity.

Variables	Foreign institutions		Market makers		Domestic institutions		Individual investors	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: low aggregate option volume (below 33%)								
Intercept	47.01	0.1944	−118.37*	0.0576	65.85	0.2433	4.02	0.9634
β_{up}	−80.67	0.2583	282.34**	0.0482	−114.83	0.2584	−3.04	0.9894
β_{down}	−69.20	0.3085	275.32**	0.0448	−92.74	0.3155	13.23	0.9573
R^2	0.0114		0.0351		0.0109		0.0004	
% of Contracts	23.91		22.18		27.50		26.41	
Panel B: medium aggregate option volume (between 33% and 67%)								
Intercept	−25.36	0.4875	46.70	0.4096	43.86	0.3274	−12.67	0.8372
β_{up}	42.34	0.5408	−131.06	0.3035	−100.90	0.2226	4.71	0.9745
β_{down}	22.77	0.7120	−120.34	0.3217	−93.50	0.2224	5.21	0.9750
R^2	0.0034		0.0089		0.0131		0.0000	
% of Contracts	34.00		32.49		33.41		32.92	
Panel C: high aggregate option volume (above 67%)								
Intercept	52.98	0.1836	−77.17	0.2875	−61.47	0.3064	−51.69	0.4912
β_{up}	−88.19	0.2856	202.56	0.2130	146.36	0.1819	172.50	0.3589
β_{down}	**−120.54***	0.0680	122.57	0.3554	74.56	0.4396	102.26	0.6131
R^2	0.0308		0.0161		0.0223		0.0146	
% of contracts	42.09		45.33		39.09		40.67	

This table reports the predictive regression results conditional on daily options trading volume and trader classes; the 367 trading days are sorted into three equal-sized sub-samples based on the daily option trading volume. The regression model carried out for each volume tertile is:

$$R_{t+1} = \alpha_i + \beta_{i,up}^{OB,\text{volume percentile}} X_{i,t}^{OB,\text{volume percentile}} \times D_t + \beta_{i,down}^{OB,\text{volume percentile}} X_{i,t}^{OB,\text{volume percentile}} \times (1 - D_t) + \varepsilon_{i,t}$$
$$D_t = \begin{cases} 1, R_t > 0; \\ 0, otherwise \end{cases},$$

where R_{t+1} is the daily close-to-close spot index return on day $t+1$; X_S are the open-buy put-call ratios; and D is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The open-buy put-call ratio is calculated by dividing the open-buy puts by the sum of the open-buy puts and calls. The '% of Contracts' refers to the percentage of open-buy volume within the specific trader class. Bold numbers indicate coefficients with correct predictive signs and correct statistical significance.

* Indicates statistical significance at the 10% level.

** Indicates statistical significance at the 5% level.

change of 63.82 points, the −13.48 basis points approximate to a −11.43 change in the index level ($-13.48 \times 10^{-3} \times 8476$), which is 18 per cent of the median daily index movement (11.43/63.82).

When taking into consideration the slope coefficient of 176.63 basis points in Eq. (3), this suggests that a one standard deviation change in the put-call ratio is associated with a −31.42 index movement, which accounts for 49 per cent of the median daily index change in our sample period. These results indicate that the put-call ratios of foreign institutional investors predict a non-trivial portion of the index movements, and thus, should be considered to be of economic significance. The slope coefficients are six times greater when we examine a sub-sample containing only those days with important macroeconomic news events (Table 8).

5.2. Market activity and the predictive ability of options

We go on in this section to examine whether there are any variations in the predictive ability of trading by foreign institutional investors under different levels of option market activity. Studies have long viewed trading volume and information flow as inseparable; for example, in the 'sequential arrival of information' model proposed by Copeland (1976), the gradual arrival and dissemination of new information results in movements in both trading volume and price.[17]

[17] Evidence of volume stimulated by information was found by Kim and Verrecchia (1991), who demonstrated that trading volume is proportional to the degree of information asymmetry prior to scheduled earning announcements. Cao et al. (2005)

Table 5
Predictive ability of the open-buy ratio, by option market characteristics.

Variables	Foreign institutions		Market makers		Domestic institutions		Individual investors	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: moneyness								
a. In- and near-the-money								
Intercept	17.56	0.2995	23.35	0.2032	−1.28	0.9390	−4.99	0.8076
β_{up}	−39.71	0.3262	−81.22	0.1528	3.51	0.9335	12.30	0.8482
β_{down}	−40.05	0.1889	−47.71	0.1913	−2.82	0.9228	7.68	0.8727
R^2	0.0048		0.0061		0.0001		0.0001	
% of contracts	31.35		41.99		36.00		38.24	
b. Out-of-the-money								
Intercept	24.16	0.2047	−35.73	0.0917	−14.21	0.5240	−25.79	0.2290
β_{up}	−36.62	0.2833	70.25	0.0733	22.02	0.5327	60.15	0.1891
β_{down}	**−54.04***	0.0943	65.21	0.1453	19.61	0.6000	59.37	0.3403
R^2	0.0078		0.0088		0.0011		0.0048	
% of contracts	50.40		43.61		44.82		42.07	
A.3 Deeply out-of-the-money								
Intercept	−10.77	0.5164	−31.91	0.1400	−32.06	0.1152	−34.39*	0.0607
β_{up}	22.52	0.3881	42.30	0.1455	45.45*	0.0955	55.99**	0.0798
β_{down}	3.13	0.9056	36.94	0.2778	39.49	0.2211	68.65	0.1160
R^2	0.0031		0.0060		0.0083		0.0093	
% of contracts	18.25		14.40		19.18		19.69	
Panel B: time to maturity								
a. Short (less than 30 days)								
Intercept	19.35	0.3391	−21.62	0.5322	14.23	0.6353	−12.74	0.7582
β_{up}	−27.20	0.4794	54.54	0.4893	−22.07	0.6925	38.01	0.7108
β_{down}	−49.96	0.1565	31.82	0.6534	−34.13	0.4965	16.92	0.8798
R^2	0.0066		0.0019		0.0018		0.0012	
% of contracts	71.84		91.87		91.09		93.21	
b. Medium (30–90 days)								
Intercept	22.01	0.1525	9.05	0.6272	−23.67	0.2804	−9.11	0.5824
β_{up}	−38.32	0.2000	−25.06	0.4894	54.41*	0.0912	37.24	0.4601
β_{down}	**−51.65***	0.0517	−17.84	0.5774	27.40	0.4198	8.18	0.8981
R^2	0.0106		0.0014		0.0136		0.0021	
% of contracts	26.69		7.86		8.70		6.65	
c. Long (more than 90 days)								
Intercept	−8.87	0.6215	0.88	0.9617	5.18	0.9619	9.73	0.4447
β_{up}	26.43	0.3807	2.98	0.9143	−4.31	0.9716	−33.68	0.3702
β_{down}	13.32	0.6481	−13.24	0.6082	5.76	0.9626	−45.61	0.3047
R^2	0.0029		0.0021		0.0019		0.0036	
% of contracts	1.47		0.27		0.21		0.13	

This table reports the results of the following predictive regression model, by option characteristics (moneyness or maturity) and trader classes:

$$R_{t+1} = \alpha_i + \beta_{i,up}^{OB,option\ \ leverage} X_{i,t}^{OB,\ \ option\ \ leverage} \times D_t + \beta_{i,down}^{OB,option\ \ leverage} X_{i,t}^{OB,option\ \ leverage} \times (1 - D_t) + \varepsilon_{i,t},$$

where R_{t+1} is the next-day spot index return; X_S are the open-buy put-call volume ratios calculated for a specific type (moneyness or maturity) of options; and D is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The open-buy put-call ratio is calculated by dividing the open-buy put volume by the sum of the open-buy put and call volume for the corresponding type of options. The '% of Contracts' in each panel refers to the open-buy volume of that category as a percentage of the total open-buy volume for the entire class of traders. We define In- and Near-the-Money options as those with strike-to-spot ratios between 0.98 and 1.02, Out-of-the-Money calls as those with strike-to-spot ratios between 1.02 and 1.07, and Out-of-the-Money puts as those with strike-to-spot ratios between 0.93 and 0.98. All other options are classified as Deeply Out-of-the-Money options. Those options that expire within 30 days are classified as short maturity options, those expiring between 30 to 90 days as medium maturity options, and the remainder as long maturity options. The '% of Contracts' refers to the percentage of open-buy volume within the specific trader class. Bold numbers indicate coefficients with correct predictive signs and correct statistical significance.

* Indicates statistical significance at the 10% level.
** Indicates statistical significance at the 5% level.

An alternative explanation of the association between volume and information was also offered by Kyle (1985) and Admati and Pfeiderer (1988), who suggested that in order to both conceal their information and lower the price impact, informed investors would tend to trade when liquidity trading was in plentiful supply.[18] Both theories imply that the timing of order submissions by informed traders is related to market activity.

To identify whether informed trading on the TXO is dependent on market activity, we sort the 367 trading days into three equal-sized sub-samples based on daily option trading volume. The predictive regression Eq. (1) is then separately carried out for each volume tertile sub-sample. A negative and significant β coefficient would indicate that the put-call volume ratio correctly predicts the next-day index return. As shown in Table 4, only the trading volume of foreign institutional investors in the highest volume tertile is found to have a significant β coefficient and a sign consistent with its predictive ability. In Panel C the regression R^2 for foreign institutional investors is found to be the highest amongst all trader classes. This concentration of information trading during periods of high volume is consistent with the implications of the sequential arrival of information and the intention to conceal information.

Chordia and Swaminathan (2000) found that high-volume stocks exhibited rapid responses to market-wide information, whereas low-volume stocks tended to respond very slowly; thus, they asserted that trading volume played a significant role in the dissemination of market-wide information. In the present study, we present evidence in support of their assertion, albeit in the index options market, where prices are determined mainly by market-wide information.

Our results also provide support for the proposition that traders will try to conceal their superior information by trading when there is greater liquidity-motivated volume within the market. Emphasizing the differences between trading based on private information and public information that is subject to different interpretations, Bamber et al. (1999) reported that trading based on traders' own interpretations of publicly-available information tended to be more intensive when trading volume was higher, essentially because a high volume of liquidity trading helps to camouflage their transactions. Our finding of the significant predictive ability of trading by foreign institutional investors during periods of high volume reinforces the findings of Bamber et al. (1999) that traders acting on their differential interpretation elect to trade when volume is higher.

The remaining findings in Table 4 are largely consistent with the results reported in Table 2, with the significant predictive ability of the option positions of foreign institutional investors only being discernible in a downward market. In the market maker regressions, the two β coefficients in the lowest volume tertile are found to be positive with statistical significance, thereby indicating that the obligation to provide liquidity when overall liquidity is low exposes option market makers to adverse selection risk. The put-call ratios of individual investors and the volume ratios of domestic institutional investors are found to have little or no information content on future index movements in any of the volume tertiles.

5.3. Contract selection by informed traders

In this section, we explore whether informed traders favor certain types of options when adopting an open-buy strategy. Specifically, we examine the predictive ability of open-buy volume for options at various levels of moneyness and maturity.

It was argued in both Black (1975) and Easley et al. (1998) that informed traders often prefer to trade in equity options, as opposed to the underlying asset, essentially because the high leverage available in options trading raises the potential profits from informed trading. Accordingly, when faced with multiple series of options, informed traders may choose out-of-the-money options, since they provide

also reported abnormally high trading volume in equity options prior to takeover announcements, indicating that traders with superior ability, in terms of their interpretation of information, trade ahead of such announcements.

[18] Chakravarty et al. (2004) found that option markets were more informative when the trading volume was high and the effective spreads were narrower. Blau et al. (2009) provided empirical evidence to show that asymmetric information was greater during periods of high volume, when informed traders were able to submit their orders without revealing their private information.

higher leverage than either in-the-money or near-the-money options. The leverage consideration of contract selection is empirically supported by Chakravarty et al. (2004), who found significant intraday price discovery for out-of-the-money options as compared to at-the-money options, and Kaul et al. (2004), who showed that informed traders specifically choose to trade in options with good liquidity and high leverage.

We classify options into three categories of leverage, based upon their strike-to-spot ratios. In-the-money and near-the-money options are calls and puts with strike-to-spot ratios between 0.98 and 1.02, whilst out-of-the-money options are calls with strike-to-spot ratios between 1.02 and 1.07 and puts with strike-to-spot ratios between 0.93 and 0.98. Deeply out-of-the-money options are calls with strike-to-spot ratios above 1.07 and puts with strike-to-spot ratios below 0.93. The predictive regression in Eq. (1) is then carried out once again using the volume ratio constructed from options in each category of moneyness.

As shown in Panel A of Table 5, the only significant put-call volume ratio is found in the out-of-the-money options trading of foreign institutional investors during a downward market; although in-the-money and near-the-money options traded by this group convey correct information on next-day index movements, the coefficients are not statistically significant. None of the other trader classes exhibit any significant predictive ability in any category of moneyness. These findings are consistent with the leverage hypothesis, that informed traders prefer to use high-leverage contracts in order to capitalize on their superior information. Our results also confirm the findings of the studies of Ahn et al. (2008), Chang et al. (2009) and Chan et al. (2009), each of which reported a tendency for out-of-the-money options to lead the equity index in price discovery.

Aside from leverage, liquidity is an additional and critical consideration in the selection of which contracts to trade in. Informed traders have an incentive to trade in a liquid market in order to conceal their private information and minimize the market impact costs (Kyle, 1985). We use time-to-expiration as a proxy for option liquidity, classifying the options into three maturity ranges: less than 30 days, between 30 and 90 days, and longer than 90 days, where the short-term (less than 30 days) options are the most liquid and the long-term (longer than 90 days) options are the least liquid.

Our predictive regressions using the volume ratio constructed from options in each maturity category are presented in Panel B of Table 5. Surprisingly, the only variable with a sign correctly and significantly predicting the next-day index return is the open-buy ratio of foreign institutional investors in medium-term options, and not, as might be expected, the short-term options with the best liquidity. This finding is, nevertheless, consistent with those reported by Han et al. (2009) and Chang et al. (2009), both of which undertook analyses into TXO options and found better information content in medium- maturity options as compared to short- maturity options.

This result obviously gives rise to the question of why foreign institutional investors do not choose to concentrate their informed trading in short-term contracts, where there is sufficient liquidity, and the answer may relate to the time-decay nature of options. The closer the expiration date, the larger the theta, and thus, the more the option value is diminished with each passing day. The very nature of increasing value decay over time is detrimental to holding short-term long option positions. Informed traders, who tend to hold long positions (recall our findings in Tables 2 and 4), can mitigate the extent of the value decay by selecting contracts with longer time-to-expiration.

An additional merit of the use of longer-term options is that out-of-the-money options have greater deltas when the options have longer time-to-expiration (Bakshi et al., 2000). Thus, in order to gain the maximum possible benefit from their informational advantage, foreign institutional investors will tend to select the medium-term contracts, with high delta exposure, among the out-of-the-money options. This contract selection of informed traders is also revealed by their proportional holding of options across maturities.

As shown in the '% of contracts' in Panel B of Table 5, with the exception of foreign institutional investors, all traders devoted over 90 per cent of their volume to short-term options. In contrast, foreign institutional investors are found to have traded more in medium-term options (26.69 per cent) than other traders (less than 9 per cent). The regression results therefore suggest that the preference for medium-term options amongst foreign institutional investors could be motivated by the opportunity for informed trading.

In summary, we find that the out-of-the-money and medium-maturity options traded by foreign institutional investors have richer information content, and that the decisions made by informed traders with regard to their contract selection reflect their willingness to sacrifice liquidity for high leverage, high delta and low theta.

5.4. Stealth trading in the index options markets

In this section, we go on to explore the information content of options trading using different trade sizes in an attempt to provide direct evidence of 'stealth trading' in the index options market. The stealth-trading hypothesis proposed by Barclay et al. (1993) suggests that informed traders will often fragment their large orders in order to reduce the impact on prices and slow down the process of disclosure of their valuable information. As a result, it is the medium-sized trades which tend to have the richest information content and which are most likely to move prices. Although a handful of studies have provided support for this hypothesis in the stock markets, there is less evidence within the derivative markets.[19]

Following Anand and Chakravarty (2007), we define small-sized options trades as those transactions comprising of 1–4 contracts, medium-sized trades as those ranging between 5 and 99 contracts, and large-sized trade as those involving 100 contracts or more. We then go on to re-calculate the put-call ratios for each class of traders, by trade-size groups, and undertake the predictive regression in Eq. (1) for each of these trade-size groups. The results are reported in Table 6.

The β_{down} coefficient in the regression on foreign institutional investors in a downward market is negative for all three trade sizes; however, it is only in the medium-sized regression (Panel B) that the coefficient is found to be statistically significant. The significant informational role of the medium-sized trades made by foreign institutional investors is consistent with the stealth trading hypothesis. Indeed, Chou and Wang (2009) noted frequent order-splitting behavior amongst foreign institutional investors in the Taiwan futures market.

It would seem that when engaging in informed trading, foreign institutional investors in Taiwan tend to split their large orders into medium-sized orders, with their medium-sized trades ultimately providing the best predictions on future index movements. Our findings on index options are consistent with those reported on equity options by Anand and Chakravarty (2007), where informed traders were also found to prefer medium-sized trades.

As shown in Table 6, approximately 34 per cent of the transactions made by retail traders are small-sized trades, with these trades significantly predicting the wrong direction of changes in the index. According to Easley and O'Hara (1987), small trades are likely to be attributable to noise traders; we also show that small trades by retail investors have very little information content, and indeed, we find that such trades tend to suffer from immediate short-term losses. Our results on individual traders are consistent with the evidence on the Taiwan stock market provided by Barber et al. (2009), where retail investors were found to suffer substantial trading losses.

5.5. Choice of order types by informed traders

Another trading decision which has to be made by informed traders in the options market is the choice between market orders and limit orders. Under the traditional view, the assumption is that informed traders will place market orders only, essentially because the immediacy of these orders allows such informed traders to take up their positions before their information leaks out (Rock, 1990;

[19] As regards evidence on the stock markets, Barclay et al. (1993) found that medium-sized trades accounted for an estimated 92.8 per cent of the cumulative price change during pre-tender offer announcement periods; Chakravarty (2001) noted that informative trades on the NYSE were almost entirely attributable to the medium-sized trades initiated by institutions; and Alexander and Peterson (2007) provided further evidence of increased clustering of medium-sized trades on the NYSE and Nasdaq, which tended to have greater price impact than large rounded trades. The first evidence on derivatives markets was presented by Anand and Chakravarty (2007), who documented a preference amongst informed traders for medium-sized trades in equity options.

Table 6
Predictive ability of the open-buy ratio, by different trade sizes.

Variables	Foreign institutions		Market makers		Domestic institutions		Individual investors	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: small-sized trades (1–4 contracts)								
Intercept	0.44	0.9855	−41.24	0.3044	−2.37	0.9435	−89.37*	0.0505
β_{up}	8.98	0.8422	93.56	0.2905	10.64	0.8664	207.17**	0.0463
β_{down}	−15.07	0.7009	70.88	0.3590	−7.82	0.8938	228.30*	0.0646
R^2	0.0027		0.0032		0.0013		0.0109	
% of contracts	9.57		9.13		20.07		33.57	
Panel B: medium-sized trades (5–99 contracts)								
Intercept	34.13	0.1057	−46.85	0.1657	32.43	0.2651	7.71	0.8351
β_{up}	−59.19	0.1566	111.50	0.1538	−53.55	0.3060	−14.54	0.8795
β_{down}	**−74.30****	0.0450	86.57	0.2101	−62.24	0.1847	−36.31	0.7217
R^2	0.0111		0.0056		0.0050		0.0009	
% of contracts	76.98		86.63		75.98		63.18	
Panel C: large-sized trades (100+ contracts)								
Intercept	2.16	0.9070	7.62	0.7297	1.33	0.9724	−5.17	0.7620
β_{up}	1.34	0.9687	−10.88	0.7567	12.10	0.8005	16.42	0.7068
β_{down}	−17.19	0.5477	−23.73	0.4950	8.74	0.8469	−4.10	0.9285
R^2	0.0022		0.0018		0.0005		0.0010	
% of contracts	13.45		4.24		3.96		3.25	

This table reports the results on trade size and trader class; within each class of traders, with open-buy trades being grouped into three trade size categories: small (1–4 contracts), medium (5–99 contracts) and large (100+ contracts), based upon the following predictive regression:

$$R_{t+1} = \alpha_i + \beta_{i,\ up}^{OB,\ trade\ size} X_{i,\ t}^{OB,\ trade\ size} \times D_t + \beta_{i,\ down}^{OB,\ trade\ size} X_{i,\ t}^{OB,\ trade\ size} \times (1 - D_t) + \varepsilon_{i,t},$$

where R_{t+1} is the next-day spot index return; X_S is the informational variable of the open-buy put-call ratio; and D is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The open-buy put-call ratio is calculated by dividing the open-buy puts by the sum of the open-buy puts and calls. The '% of Contracts' refers to the number of open-buy contracts traded in a particular size category to the total open-buy volume within the specific trader class. Bold numbers indicate coefficients with correct predictive signs and statistical significance.

* Indicates statistical significance at the 10% level.

** Indicates statistical significance at the 5% level.

Glosten, 1994). However, as argued by Anand et al. (2005), informed traders can use limit orders as an additional means of stealth trading to effectively conceal their information-based trading intentions.

Unlike market orders, which offer immediacy at the expense of bid-ask spreads, traders placing limit orders can patiently wait for better prices, although they are faced with the risk of non-execution of their orders. Hence, the trade-off between the probability of execution and the transaction price should be found to play quite a key role in the decisions taken by investors on which type of orders to use (Bloomfield et al., 2005; Kaniel and Liu, 2006).

We recalculate the open-buy put-call volume ratios of the underlying trades for each class of investors, based upon the exclusive use of either limit orders or market orders, with the results of the predictive regression using Eq. (1) for the market-order and limit-order volume ratios being reported in separate panels in Table 7. A significantly negative β_i^{mkt} (β_i^{lmt}) would indicate that informed traders in the TXO market tend to use market (limit) orders to exploit their informational advantage.

The results of the market-order volume ratio are reported in Panel A of Table 7, where no significantly negative coefficients are discernible; this indicates that the executed market orders have little or no information content on future index returns. The results for limit orders are reported in Panel B of Table 7, from which we find a significantly negative β_i^{lmt} for the put-call ratio of foreign institutional investors during a downward market; this suggests that informed trading by foreign institutional investors tends to focus on the submission and execution of limit orders, and not market orders.

Our finding of richer information content in limit orders than market orders is consistent with the experimental results of Bloomfield et al. (2005), as well as the empirical findings of Anand et al.

Table 7
Predictive ability of the open-buy ratio, by order types.

Variables	Foreign institutions		Market makers		Domestic institutions		Individual investors	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: market orders								
Intercept	−70.16	0.3867	−22.99	0.3298	−15.98	0.3162	−64.04*	0.0712
β_{up}	4.21	0.9708	13.50	0.6762	44.55	0.2086	170.91*	0.0636
β_{down}	13.72	0.8867	37.64	0.2460	24.89	0.3927	140.48*	0.0959
R^2	0.0011		0.0076		0.0044		0.0095	
% of contracts	1.00		0.19		4.65		7.66	
Panel B: limit orders								
Intercept	29.11	0.1665	−49.19	0.1602	20.88	0.4801	−12.94	0.7473
β_{up}	−47.75	0.2450	114.87	0.1482	−34.05	0.5209	37.09	0.7109
β_{down}	**−64.98***	0.0740	89.35	0.2034	−43.16	0.3757	21.48	0.8491
R^2	0.0091		0.0058		0.0024		0.0009	
% of contracts	99.00		99.81		95.35		92.34	

This table reports the results on order types and trader classes with all of the transactions within each class of traders being divided into two sub-samples depending on whether the original orders were market or limit orders, based upon the following predictive regression:

$$R_{t+1} = \alpha_i + \beta^{OB,\ order\ type}_{i,\ up} X^{OB,\ order\ type}_{i,\ t} \times D_t + \beta^{OB,\ order\ type}_{i,\ down} X^{OB,\ order\ type}_{i,\ t} \times (1 - D_t) + \varepsilon_{i,t},$$

where R_{t+1} is the next-day spot index return; X_S is the open-buy put-call ratio executed by either market orders or limit orders; and D is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The put-call ratio is calculated by dividing the open-buy puts by the sum of the open-buy puts and calls. The '% of Contracts' in each panel refers to the number of open-buy contracts traded in a particular size category to the total open-buy volume within the specific trader class. Bold numbers indicate coefficients with correct predictive signs and statistical significance.

* Indicates statistical significance at the 10% level.

(2005) and Beber and Caglio (2004). The reason for informed traders in the TXO market exhibiting a preference for limit orders may well have been appropriately explained by Kaniel and Liu (2006); according to their model, informed traders assess the trade-off between execution risk (greater for limit orders) and market impact costs (higher for market orders) and may elect to trade using limit orders if they have a sufficiently long information horizon. Since longer-lived information cannot be easily comprehended or acquired by other traders, it tends to be gradually incorporated into the price, thereby lowering the execution risk and making limit orders more attractive.

Our finding of a preference amongst foreign institutional investors for the use of limit orders when engaging in informed trading indicates that they could possess such long-horizon information, and thus, are less concerned with the execution risk associated with a limit order strategy. Chou and Wang (2009) suggested that the informational advantage in a particular index may originate from superior interpretation of public information. Unlike inside or private information on individual stocks, an informational advantage based on such knowledge is more difficult for other market participants to comprehend and copy, and thus, tends to remain profitable over a longer period of time.

5.6. *Informed trading and macroeconomic news*

We go on in this section to investigate the linkage between public information and the predictive ability of the option volume of foreign institutional investors. Recent studies have documented abnormal equity option transactions immediately prior to the earnings announcement of underlying stocks; for example, Amin and Lee (1997) found that open interest in options increased prior to earnings announcements, thereby exhibiting some degree of predictive power for the direction of earnings surprises. Roll et al. (2010) also showed that an increase in the option-to-stock volume ratio prior to an earnings announcement was associated with a greater absolute price movement after the announcement.

However, the studies that have been carried out thus far have tended to focus only on equity options and firm-specific information. In this section, we extend the current literature by showing that index

Table 8
Predictive ability of the open-buy ratio on upcoming events.

Variables	Foreign institutions		Market makers		Domestic institutions		Individual investors	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: domestic macroeconomic news (27 event days)								
Intercept	140.06	0.2630	123.36	0.6384	−177.04	0.4781	−35.70	0.9177
β_{up}	−195.34	0.4584	−169.73	0.7700	335.96	0.3893	199.54	0.8237
β_{down}	**−498.20****	0.0345	−568.47	0.3245	86.31	0.8357	−263.16	0.7864
R^2	0.238		0.1448		0.1142		0.1069	
Panel B: global macroeconomic news (40 event days)								
Intercept	129.85	0.2329	−99.03	0.4995	−81.76	0.5909	−335.25	0.1401
β_{up}	**−389.27***	0.0793	97.31	0.7689	53.98	0.8417	710.77	0.2336
β_{down}	**−425.39****	0.0379	−15.96	0.9579	−45.99	0.8500	661.94	0.2902
R^2	0.1114		0.0155		0.0203		0.04	
Panel C: no macroeconomic news (305 days)								
Intercept	11.80	0.5470	−51.41	0.1158	42.80	0.1257	11.04	0.7663
β_{up}	−4.37	0.9093	127.17*	0.0866	−69.33	0.1813	−10.69	0.9073
β_{down}	−5.42	0.8715	132.86*	0.0438	−48.63	0.2903	2.55	0.9799
R^2	0.0001		0.0138		0.0062		0.0005	

This table reports the results for sample days with domestic macroeconomic news, global macroeconomic news, or no news, based upon the following predictive regression:

$$R_{t+1} = \alpha + \beta_{up}^{OB} X_t^{OB} \times D_t + \beta_{down}^{OB} X_t^{OB} \times (1 - D_t) + \varepsilon_t,$$

where R_{t+1} is the spot index return at the announcement date; X_S are the open-buy put-call ratios prior to the announcement; and D is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The open-buy put-call ratio is calculated by dividing the open-buy put volume by the sum of the open-buy put and call volume for the corresponding type of options. Bold numbers indicate coefficients with correct predictive signs and statistical significance.

* Indicates statistical significance at the 10% level.

** Indicates statistical significance at the 5% level.

option volume becomes more informative prior to macroeconomic news announcements, with our empirical results uncovering the sources of information advantages possessed by informed traders in the index markets.

Using keywords of "subprime mortgage loan/global financial crisis" and "Taiwan economy forecast/Taiwan response to global financial crisis", we carried out a search of the UDN database for influential macroeconomic news events during our study period.[20] The search produced a total of 40 global events, mainly related to the subprime mortgage crisis, and 27 domestic events, mainly involving announcements of domestic financial policy changes, economic prediction updates and changes in political atmosphere.[21]

In order to investigate whether the volume of index options is particularly informative on days with important news events, we split the 372 sample days into three sub-samples comprising of 27 days with domestic announcements, 40 days of global events and the remaining 305 days with no discernible macroeconomic news. We then carried out predictive regressions on each sub-sample for each of the four classes of investors, and found that the predictive ability of foreign institutional investors is particularly significant on those days on which there were important macroeconomic news events.

As shown in Table 8, the volume ratio of foreign institutional investors correctly predicts the aggregate market movement for those sub-samples with announcement dates of either domestic or global macroeconomic news. The β coefficients in Panel A of Table 8 are found to be significantly negative for domestic news in downward markets, whilst those in Panel B are found to be significantly

[20] The UDN database is a publicly accessible Taiwan news website (http://udndata.com) which contains more than 11 million global news items reported since 1951.

[21] A brief description of the 68 events is provided in Appendix A.

negative for global news in both upward and downward markets. The magnitude of the coefficients is clearly of economic significance; for example, for one standard deviation change in the put-call ratio of foreign institutional investors, the slope coefficient of −425.39 in a downward market on global news announcement dates translates into a change of 70 index points over one day. Only 40 per cent of the days in our sample period have changes above 70 index points.

As shown in Panel C of Table 8, on days with no macroeconomic news, the option volume ratio of foreign institutional investors has no observable predictive ability, whilst any adjustment in the option positions of the remaining three classes of traders are not found to be significantly linked to movements in the index on days with or without news announcements. These results indicate that informed trading by foreign institutional investors in the index option markets is driven by macroeconomic news.

Our findings suggest that foreign institutional investors are more certain, or more knowledgeable, about upcoming events affecting the aggregate market; hence, their transactions in advance of such news announcements are able to explain a greater proportion of the variation in the index movement caused by these information shocks. The evidence presented here provides support for the view of Grinblatt and Keloharju (2000), that foreign institutional investors have a better global perspective than local market traders, since their ability, with regard to the correct interpretation of global macroeconomic conditions, enables them to adjust their option positions in the correct direction quicker than other local market traders.

It is, however, somewhat surprising to find that foreign institutional investors also adjust their option positions prior to domestic macroeconomic news announcements, although a careful examination of these domestic announcements (see Appendix A) reveals that many of these domestic events are in fact the result of changes in global economic conditions, such as the subprime mortgage crisis; clearly, their understanding of the global economy may well convert to advantages in predicting aggregate market changes based upon domestic issues.[22] In summary, our results confirm that the predictive ability of foreign institutional investors in the index option markets is strongly associated with their knowledge of changes in macroeconomic conditions.

5.7. *Predictive ability of options during financial crises*

The results presented so far reveal the superior informational role of foreign institutional investors in the options market during 'normal' trading; however, in the last half of 2008, as in many other countries, the financial market in Taiwan was severely hit by the global financial crisis, during which the TWI stock index fell by 50 per cent, whilst the standard deviation in the daily return increased from 1.47 per cent in the previous sample period to 2.47 per cent.

It is unclear how the market turbulence in 2008 influenced the predictive ability of foreign institutional investors. Their predictive ability may well be enhanced during periods of crisis when global macroeconomic events dominate the overall market trend, with their knowledge of the changes in macroeconomic conditions providing them with ample opportunities for profit, as long as their prior experience remains applicable in such extreme markets. Conversely, their predictive power could be weakened if the magnitude of such turbulence was beyond their expectations or if they were forced to adopt different investment strategies as a result of tighter financial constraints.

In an attempt to determine whether the predictive power of foreign institutional investors also prevails in a turbulent market, we carry out a separate examination of the sample period from July 1, 2008 to December 31, 2008 as an extension of the results presented above. Panel A of Table 9 reports the regression results of Eqs. (1) and (3) on the volume ratio for foreign institutional investors, whilst Panel B reports the predictive regression results of Eq. (1) on three sub-samples comprising of those days with domestic macroeconomic news, global macroeconomic news and no news.

The results show that the predictive ability of foreign institutional investors completely disappeared during the financial crisis period, with none of the coefficients in either equation being

[22] Since our dependent variable is the return of the domestic stock index, it is natural to observe more direct impacts from domestic news than global news.

Table 9
Extended analysis of the financial crisis sample period (Jul 2008–December 2008).

Variables	Expected sign if with predictive ability	Eq. (3)		Eq. (1)	
		Coefficient	*p*-Value	Coefficient	*p*-Value
Panel A: predictive ability of option put-call volume ratios					
Intercept		37.58	0.7532	−68.62	0.2847
β_{up}^{OB}	−	58.46	0.7862	59.80	0.7285
β_{up}^{OS}	+	−175.86	0.4156	–	–
β_{up}^{CB}	−	−65.98	0.7082	–	–
β_{up}^{CS}	+	−18.50	0.8951	–	–
β_{down}^{OB}	−	70.17	0.6780	77.81	0.5460
β_{down}^{OS}	+	−251.58	0.2161	–	–
β_{down}^{CB}	−	15.03	0.9167	–	–
β_{down}^{CS}	+	21.51	0.8665	–	–
R^2		0.0203		0.0033	

Variables	Domestic news (12 days)		Global news (9 days)		No news (109 days)	
	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
Panel B: predictive ability based on macroeconomic news events						
Intercept	−219.14	0.2257	−381.51	0.3626	−19.32	0.7733
β_{up}	75.07	0.8918	−430.53	0.7419	9.51	0.9572
β_{down}	97.17	0.7912	772.89	0.3549	7.66	0.9545
R^2	0.0086		0.4795		0.0001	

This table reports the results from re-running the regression analysis in Tables 2 and 8 for foreign institutional investors, using the financial crisis sample period, from 1 July 2008 to 31 December 2008, with Panel A reporting the results of the following predictive regressions:

$$R_{t+1} = \alpha + \beta_{up}^{OB} X_t^{OB} \times D_t + \beta_{down}^{OB} X_t^{OB} \times (1 - D_t) + \varepsilon_t \tag{1}$$

$$R_{t+1} = \alpha + \left[\beta_{up}^{OB} X_t^{OB} + \beta_{up}^{OS} X_t^{OS} + \beta_{up}^{CB} X_t^{CB} + \beta_{up}^{CS} X_t^{CS}\right] \times D_t + \left[\beta_{down}^{OB} X_t^{OB} + \beta_{down}^{OS} X_t^{OS} + \beta_{down}^{CB} X_t^{CB} + \beta_{down}^{CS} X_t^{CS}\right] \times (1 - D_t) + \varepsilon_t, \tag{3}$$

where R_{t+1} is the daily close-to-close spot index return on day $t+1$; X_t $(= P_t/(P_t + C_t))$ are the put-call volume ratios calculated using the open-buy (*OB*) and open-sell (*OS*) volume, and close-buy (*CB*) and close-sell (*CS*) volume of foreign institutional investors; and *D* is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The signs of the coefficients supporting the predictive ability of the volume ratio are indicated by a plus (+) or a minus (−) in the first column.
Panel B reports the results for sample days with domestic macroeconomic news, global macroeconomic news and no news, based upon following predictive regression:

$$R_{t+1} = \alpha + \beta_{up}^{OB} X_t^{OB} \times D_t + \beta_{down}^{OB} X_t^{OB} \times (1 - D_t) + \varepsilon_t,$$

where R_{t+1} is the spot index return at the announcement date; X_S are the open-buy put-call ratios prior to the announcement; and *D* is an indicative variable which is equal to 1 if $R_t > 0$; otherwise 0. The open-buy put-call ratio is calculated by dividing the open-buy put volume by the sum of the open-buy put and call volume of foreign institutional investors.

found to have any statistical significance. Although not statistically significant, the signs of the open-buy volume ratios are found to be positive in both regressions, thereby indicating that foreign institutional investors were tending to sell more calls (puts) and/or buy more puts (calls) prior to an increase (decrease) in the index; this trading direction is totally opposite to that shown in Panel A of Table 2.

The results in Panel B also confirm the absence of the predictive power of foreign institutional investors in a turbulent market, with most of the regression coefficients being found to be positive, and none of them exhibiting statistical significance. It appears that knowledge of upcoming global macroeconomic events was of no help to foreign institutional investors in the second half of 2008 in terms of their ability to synthesize profitable trading strategies. This is in stark contrast to the results

reported in Table 8 on their predictive ability based upon macroeconomic events under normal market conditions.

The absence of predictive power amongst foreign institutional investors in late 2008 may be jointly attributable to three specific factors. Firstly, for the vast majority of professional market players, the market conditions during that turbulent period were totally unforeseeable, and as a result, their predictive ability was substantially weakened, essentially because their prior experience became less applicable. Secondly, faced with the increasing uncertainty in the spot markets, some foreign institutional investors may well have switched from speculative transactions to hedging when trading in options, which may be the reason why the coefficient on the open-buy volume during this period was in the opposite direction to that in the previous period. Thirdly, it is well known that foreign institutional investors were subject to serious capital constraints during this period. As their headquarters experienced a devastating liquidity problem and ordered the withdrawal of funds back to their home countries, the spot and option positions of these investors were likely to have been adjusted in ways which differed significantly from their trading behavior under normal market conditions. Below we provide some evidence for the plausibility of the three conjectures.

We first examine the changes in the foreign institutions' option trading volume in normal market (1 January 2007–30 June 2008) and turbulent market (1 July 2008–31 December 2008), as an analysis of the effect of financial constraints. The daily trading volume of TXO index option was lowered by 8.9 per cent during the crisis period, compared to its volume level prior crisis. However, volume contributed by foreign institutions reduced only 4.9 per cent. To be sure, we also compare spot market trading volume in the two sample periods. The reduction in foreign institutions' spot volume (3.27 per cent) is far smaller than the reduction in the overall market trading volume (18.46 per cent). It appears that the capital constraints faced by the headquarters of foreign institutions did not materially lower their participation in the Taiwan market.[23]

To find out whether foreign institutional investors shift their option trading from speculating to hedging, we next compare the distribution of foreign institutions' option volume among option classes in normal market and in crisis period. We calculate, for every class of traders, the average daily option volume in both sample periods by put/call options, buy/sell transactions, and open/close positions. Panel A of Table 10 reports the difference between the two sample periods within every category, as a percentage of the average daily total option volume for that class of traders in the first sample period. We find simultaneously reduction in open-buy call (4.88 per cent lower) and open-buy put positions (12.41 per cent lower). This indicates that, facing with a turbulent market, foreign institutions have taken more defensive strategies by lowering the most aggressive speculative positions. Foreign institutional investors reduced both net long-call and net long-put positions during the crisis period, respectively by 7.21 and 11.51 per cent. The decrease in long calls is a profitable move during the downward trend in the period of crisis, whereas the decrease in long puts is not. Most importantly, the large reduction in their net long put positions is inconsistent with the conjecture that foreign institutions use index options to hedge their spot market investment. For other trader classes, their proportional option volume in call and put, as shown in 'total buy - total sell', stay approximately the same in two sample periods.

Finally, to examine whether the drastically changed market condition during the crisis period was unforeseen by the foreign institutional investors, we compare traders' ability to identify large upcoming market impacts in two sample periods. We focus on a sub-sample consisting of only days in the top and bottom deciles ranked according to the next-day index returns. The ability to adjust positions prior to days of extreme movements reflects their predictability at the most critical time. We calculate the percentage of days on which foreign institutions' put-call ratio made correct prediction about the direction of the next-day index return, where a correct prediction is defined as a put-call ratio <0.5 ($\geqq 0.5$) followed by a positive (negative) R_{t+1}.

[23] To examine whether financially less constrained investors perform well during the crisis period, we examine the predictive ability of market makers, domestic institutions, and individual investors by performing similar regressions in Table 9. Results (not tabulated) suggest that none of the coefficients is statistically significant and with sign consistent with the changes of next-day index return. In addition, the predictability of these less-constrained investors is not improved relative to their performance under normal market conditions.

Table 10
Changes in option volume and percentage of correct prediction before and during crisis periods.

	Buy call	Sell call	Buy put	Sell put
Panel A: percentage changes of option volume between two sample periods				
Foreign institutions				
Open	−4.88	4.52	−12.41	3.18
Close	2.90	0.72	2.58	−1.51
Open + close	−1.98	5.24	−9.84	1.68
total buy − total sell	−7.21		−11.51	
Market makers				
Open	−4.22	−5.17	−4.72	−4.99
Close	0.99	2.41	−1.83	−1.26
Open + close	−3.22	−2.76	−6.55	−6.25
Total buy − total sell	−0.46		−0.29	
Domestic institutions				
Open	1.73	−1.00	7.11	−5.29
Close	−0.21	1.95	−4.25	7.09
Open + close	1.51	0.96	2.85	1.80
Total buy − total sell	0.56		1.06	
Individual investors				
Open	1.95	0.60	0.08	−2.21
Close	−1.10	−0.79	−2.03	−0.64
Open + close	0.85	−0.19	−1.95	−2.85
Total buy − total sell	1.04		0.90	

	Sub-sample of extreme index returns		All observations	
	Prior to crisis	During crisis	Prior to crisis	During crisis
Panel B: percentage of correct prediction				
Foreign institutions				
Positive R_{t+1}	69.44	69.23	47.47	52.83
Negative R_{t+1}	60.00	23.08	55.95	35.53
Market makers				
Positive R_{t+1}	69.44	76.92	59.60	77.36
Negative R_{t+1}	34.29	38.46	29.76	35.53
Domestic institutions				
Positive R_{t+1}	33.33	23.08	30.81	26.42
Negative R_{t+1}	65.71	69.23	67.26	75.00
Individual investors				
Positive R_{t+1}	91.67	100.00	90.91	96.23
Negative R_{t+1}	0.00	0.00	3.57	5.26

Panel A presents the difference in the percentage option volume between normal period (from 1 January 2007 to 30 June 2008) and turbulent period (from 1 July 2008 to 31 December 2008). We calculate daily mean option volume for each trader class in each sub-sample period by open-buy call, close-buy call, open-sell call, close-sell call, open-buy put, close-buy put, open-sell put, and close-sell put. Panel A reports the difference between two periods scaled by the average daily total option volume of the trader class in the normal period. Panel B reports the percentage of observations on which the put-call volume ratio correctly predicts the direction of the next-day index change, where a correct prediction is defined as a put-call volume ratio < 0.5 ($\geqq 0.5$) followed by a positive (negative) R_{t+1}. The second and third column reports percentage of such observations for the sub-sample consisting of only days in the top and bottom deciles ranked by the next-day index return. The last two columns report full sample results.

In Panel B of Table 10, it is found that foreign institutions' predictability substantially weakened during the crisis period, particularly on days of negative index returns. Prior to crisis, foreign institutions' put-call ratios are consistent with the direction of next-day index movement in 69.44 per cent of times for days of positive R_{t+1} and 60 per cent of times for days of negative R_{t+1}. During the crisis, the percentage of correct prediction remained the same for days of positive R_{t+1} but declined substantially to 23.08 per cent for days of negative R_{t+1}. Similar results are reported in the last two columns of Panel B for

the samples including all days in normal market period and during crisis: the percentage of correct prediction remained stable on days of positive index returns but dropped from 55.95 per cent to 35.53 per cent on days of negative index returns. Evidence strongly suggests that foreign institutions were over optimistic in the last half of 2008, so they failed to adjust option positions immediately before most of the sharp declining days during the crisis period. This is consistent with the regression results (β^{OB}_{down}) in Tables 2 and 9, where their predictive power of a downward market prevails in the period before crisis but vanishes during crisis period.

The decline in the predictive ability is unique to foreign institutions, since no dramatic change in the percentage of correct prediction is found for any other class of traders under any circumstance. Results suggest that the information superiority of foreign institutions under normal market was hindered by the unexpected turn of the market during the crisis period. In summary, the diminished predictive power of foreign institutional investors is more likely attributable to the sudden and unexpected market downturn, rather than capital constraints or the need for hedging their spot investments.

6. Conclusions

We have analyzed the information content of the Taiwan index options market using order submission and trade execution data which explicitly distinguishes between different classes of traders (foreign institutions, market makers, domestic institutions, and individual investors) and types of trades (buy versus sell trades, and open versus offset trades). We have identified the types of investors who are most likely to be informed traders and subsequently explored their trading decisions on market timing, contract selection, order size and order type. By analyzing the ways in which such informed traders exploit their informational advantage through the use of index options, we provide insights into the process by which market-wide information is impounded into option prices.

A predictive regression model was adopted for our analysis of the predictive ability of the put-call volume ratio of options on next-day index returns within each trader class. Our results suggesting that only foreign institutional investors possess superior information on future index movements, whereas individual investors, domestic institutional investors and market makers appear to be uninformed. The predictive power of the option positions of foreign institutional investors is, however, found to be more pronounced under normal market conditions than during a period of severe financial crisis. Further analysis shows that the reduction in the predictive ability is more likely to be attributable to the sudden and unexpected market downturn, rather than capital constraints or change of trading strategies from speculating to hedging.

Our study reveals several interesting patterns in the informed trading of foreign institutional investors. First of all, such investors tend to act on their superior information by opening up new long option positions (open-buy), which are more aggressive than open-sell, close-buy or close-sell positions. We find that the predictive ability of foreign institutional investors is more pronounced in a downward market than an upward market, with such asymmetry in their predictive ability potentially being caused by the short-sales constraints imposed on the spot market in Taiwan, since this forces informed traders to trade on their bearish mood through the use of index options. We also note that informed trading is found to be particularly active when options volume is higher.

When undertaking their informed transactions, foreign institutional investors seem to have a preference for out-of-the-money and medium-term options to the most liquid at-the-money and short-term options. Such choices in contracts reflect their preference for speculative positions aimed at achieving high leverage with out-of-the-money options and large delta exposure, and low theta risk through the use of medium-term options. However, they are prepared to sacrifice liquidity by forgoing the use of short-term options.

The medium-sized trades of foreign institutional investors are found to reveal much richer information content than both their large- and small-sized trades, a finding which is consistent with the stealth trading hypothesis, that informed traders tend to break down their order size so as to reduce the market impact costs and slow down the process of disclosure of their information.

We also find that the information-based trading carried out by foreign institutional investors tends to rely upon submission and execution based upon the use of limit orders, as opposed to market orders, which implies that foreign institutional investors in Taiwan have a long-lived informational advantage;

Table A1
This table provides a brief description of macroeconomic event days from 1 January 2007 to 31 December 2008. The UDN database (http://udndata.com) was searched using the keywords 'subprime mortgage loan/global financial crisis' for global events and 'Taiwan economy forecast/Taiwan response to global financial crisis' for domestic events. The search resulted in 49 global events and 39 domestic events.

Date	Event
Panel A: domestic events	
22 Jun 2007	Taiwan Central Bank announces rise in target rate by 0.25% to counter inflation.
28 August 2007	Taiwan Economic Institute announces better performance in manufacturing and service sectors compared to previous month, implying that Taiwan business suffered less impact than expected from the subprime mortgage crisis.
20 September 2007	Taiwan Central Bank announces rise in the target rate by 0.125% to counter inflation.
8 November 2007	Standard and Poor's forecast 10%+ growth in China's GDP in 2008, but only 4.4% for Taiwan.
12 November 2007	Taiwan Stock Exchange relaxes short sales constraint on Mid-Cap 100 index stocks for short selling below the previous close price.
14 November 2007	Investment Confidence Index drops to 104.5 in November, a record low for 2007.
19 November 2007	Taiwan authorities allow limited investment by oversea funds of domestic investment trusts in mainland China stocks.
23 November 2007	Merrill Lynch and JP Morgan Chase upgrade Taiwan's annual GDP estimates based on higher than expected third quarter GDP.
11 December 2007	JP Morgan Chase reports losses of almost US$ 36.2 billion by four major Taiwan financial holding companies due to subprime mortgage crisis.
13 December 2007	Asian Development Bank (ADB) predicts Taiwan's economic growth rate will rise to 5% in 2008 despite weak global economy.
17 December 2007	Standard Chartered Bank downgrades Taiwan's economic growth rate in 2008 due to worsening subprime mortgage crisis.
14 January 2008	KMT wins legislator election. Foreign institutions overbought Taiwan stocks, the 6th highest record of overbuying.
15 January 2008	Although announcing that the Taiwan Investor Confidence Index was down to 104.2, lowest of the year, J.P. Morgan positive on Taiwan's politics and its relationship with China.
22 January 2008	Taiwan stock index plunges 528 points due to global financial crisis.
25 January 2008	UBS upgrades Taiwan stock rating on increased demand for exports from the emerging markets.
29 January 2008	Taiwan Institute of Economic Research revises down Taiwanese annual GDP to 4.9% due to worsening subprime mortgage crisis.
17 February 2008	Cathay Financial Holdings, one of the largest financial holding companies in Taiwan, announces upward revision of losses from the subprime mortgage crisis.
22 February 2008	Directorate-General of Budget, Accounting and Statistics makes downward adjustment of the economic growth rate to 4.32%.
22 March 2008	KMT wins presidential election, resulting in expectations of more relaxed policy towards China.
24 Mar 2008	Domestic and foreign institutions have positive attitudes towards Taiwan stock market following KMT victory in presidential election.
27 March 2008	Central Bank of Taiwan raises interest rate by 0.125–3.5% to combat inflation.
30 March 2008	Citigroup lowers Taiwan GDP growth rate by 0.5%, due to sluggish economy in the US and global markets.
10 April 2008	IMF makes downward adjustment of Taiwan's economic growth rate, from 4.9% in 2007 to 3.7% in 2008. Forecast of economic growth in Taiwan drops from 5.7% in 2007 to 3.4% in 2008, the lowest in seven years.
13 May 2008	Taiwan Investor Confidence index rises to 132.1 points, an historical high.
17 June 2008	Taiwan Research Institute revises economic growth rate from 4.32% at the end of previous year to 4.68% due to lower impact from the subprime mortgage crisis.
23 June 2008	Taiwan Government eases cross-strait investment policy, allowing China capital indirect investment in Taiwan.
27 June 2008	Taiwan Central Bank raises the discount rate by 0.125% in its attempt to continue to combat inflation.
1 July 2008	TAIEX index falls 115 points.
4 July 2008	Policy of direct charter flights at weekends between Taiwan and China is finally realized.
18 September 2008	Central Bank of Taiwan lowers the reserve rate by two ticks.
1 October 2008	TSE announces temporary ban on short selling.
13 October 2008	The daily price lower limit in TSE is reduced from 7% to 3.5%.
17 October 2008	Chung-hua Institution for Economic Research lowers its economic growth rate forecast for Taiwan to 3.82%.

Table A1 (*Continued*)

Date	Event
23 October 2008	Affected by the global financial tsunami, Taiwan index falls below 5000, a 24.33% decline from the previous year end.
27 October 2008	Daily price lower limit in TSE resumed at 7%.
18 November 2008	Taiwan Government issues consumption vouchers to stimulate consumption.
28 November 2008	TSE short sales allowed when stock price is above the last close price, but still prohibited when stock price is below the last close price.
12 December 2008	Taiwan Central bank slashes discount rate to 0.75%.
15 December 2008	Taiwan and China realize long-proposed cross straits direct transportation links.
Panel B: global events	
5 March 2007	HSBC announces higher expected default rates in related subprime mortgage portfolios.
2 April 2007	Second largest US subprime mortgage company, New Century Financial Corporation, files for bankruptcy protection.
27 July 2007	Global stock markets crash for the first time due to subprime mortgage loan crisis.
1 August 2007	The stock price of American Home Mortgage (AHM) is reduced by 90% as a result of the subprime mortgage crisis
6 August 2007	American Home Mortgage Investment Corporation (AHM) files for bankruptcy
9 August 2007	Bank BNP Paribas announces three mutual funds to be expelled due to subprime mortgage crisis.
10 August 2007	Spread of the subprime mortgage crisis alarms Europe, United States, Japan and other countries to rescue market liquidity.
16 August 2007	Subprime mortgage crisis causes global stock crisis.
17 August 2007	Fed announces cut in the target rate by 0.25%.
22 August 2007	Fed announces loans of US$ 500 million to the four big banks in US, highlighting their effort to alleviate the liquidity crisis.
31 August 2007	Basis Capital in Australia announces one of its hedge funds to be expelled.
14 September 2007	Northern Rock Bank asks the Bank of England for emergency bailout due to the subprime mortgage crisis.
19 September 2007	Fed announces a slash in the target rate by 0.5%.
2 October 2007	UBS announces losses of 3.04 billion dollars, whilst global investors expect that the worst of the crisis is now over.
25 October 2007	Merrill Lynch announces losses of US$ 2.24 billion due to impacts of the subprime crisis.
31 October 2007	Fed announces a cut in its federal fund rate by 0.25%.
21 November 2007	Oil prices reach US$ 99 per barrel; Fed downgrades US GDP growth rate forecast due to subprime crisis.
12 December 2007	Fed announces a cut in the target rate by 0.25%.
19 December 2007	European Central Bank releases US$ 500 billion into the financial market to control the liquidity risk in Europe.
9 January 2008	Gold price reaches 876 dollars per ounce, the highest price in gold trading history.
11 January 2008	Bank of America (BOA) announces purchase of Countrywide Financial Corporation, the largest mortgage lender in the US.
16 January 2008	Citibank announces losses of US$ 9.8 billion due to the subprime mortgage crisis.
17 January 2008	JP Morgan Chase Bank and Wells Fargo Bank announce respective falls in revenue of 34% and 38% for 2007.
21 January 2008	Global stock crisis as a result of weak economy in the US.
22 January 2008	Fed slashes the target rate by 0.75%.
30 January 2008	Global banks suffering considerable losses from the impacts of the subprime mortgage crisis; Fed slashes the target rate by 0.5%.
15 February 2008	UBS announces loss of US$ 13.7 billion, whilst stock price of Mortgage Guaranty Insurance Corporation (MGIC) falls by 16%.
21 February 2008	Third-largest bank in Germany, Dresdner Bank, announces rescue of its structured investment vehicles (SIV) suffering losses due to subprime mortgage crisis.
29 February 2008	AIG suffered losses of US$ 5.3 billion last season. UBS warns that global losses caused by the subprime mortgage crisis will be up to US$ 600 billion.
11 March 2008	Fed announces it will inject US$ 200 billion into the financial markets to solve the subprime mortgage crisis.
13 March 2008	Global credit crisis leads to bearish trend in global stock markets.
17 March 2008	Bear Stern announces bankruptcy, shocking the global markets.
19 March 2008	Fed slashes the target rate by 0.75%
27 March 2008	Liquidity emergency in European financial markets; Swiss and UK Central Banks combine to inject capital.
16 April 2008	Intel sales performance better than market expectations, encouraging global markets.
30 April 2008	Fed cuts the target rate by 0.25%

Table A1 (*Continued*)

Date	Event
6 May 2008	UBS announces first season losses of US$ 10.9 billion.
8 May 2008	AIG suffers losses of US$ 7.8 billion, its biggest loss since it was founded in 1919.
3 June 2008	Managers at Wachovia and Washington Mutual banks asked to quit, stunning the global market.
10 June 2008	Higher oil prices cause global inflation. Chinese stock market falls by 8.11%.
15 July 2008	Crises announced at Freddie Mac and Fannie Mae.
22 August 2008	Lehman Brothers stock price falls by 8.7%.
25 August 2008	Freddie Mac (Fannie Mae) stock price falls to just US$ 2.81 (US$ 5) per share.
8 September 2008	Freddie Mac and Fannie Mae taken over by the US Finance Department.
15 September 2008	Lehman Brothers goes bankrupt.
17 September 2008	Nikkei 225 falls to lowest level since July 2005 following bankruptcy of Lehman Brothers.
25 September 2008	Washington Mutual Bank goes bankrupt.
8 October 2008	Chinese authorities announce a slash in the target rate to 0.5%.
13 October 2008	Japan Yamato Life company goes bankrupt.

immediacy is therefore of less concern. Indeed, the predictive ability of foreign institutional investors is particularly significant on days with important macroeconomic news, whereas it is completely absent on days with no news announcement.

These results confirm our supposition that the advantages possessed by foreign institutional investors in the index market are associated with publicly available information. It is, therefore, possible that their advantages in capitalization, human expertise and global perspective, along with their financial and technological resources, provide them with superior interpretative ability of publicly available information and more correct predictions on upcoming information shocks.

Appendix A.

References

Admati, A.R., Pfeiderer, P., 1988. A theory of intraday patterns: volume and price variability. Review of Financial Studies 1, 3–40.
Ahn, H.J., Kang, J., Ryu, D., 2008. Informed trading in the index options market: the case of KOSPI 200 options. Journal of Futures Markets 28, 1118–1146.
Alexander, G.J., Peterson, M.A., 2007. An analysis of trade-size clustering and its relation to stealth trading. Journal of Financial Economics 84, 435–471.
Amin, K., Lee, C., 1997. Option trading and earnings news dissemination. Contemporary Accounting Research 43, 153–192.
Anand, A., Chakraverty, S., Martell, T., 2005. Empirical evidence on the evolution of liquidity: choice of market versus limit orders by informed and uninformed traders. Journal of Financial Markets 8, 289–309.
Anand, A., Chakravarty, S., 2007. Stealth trading in options markets. Journal of Financial and Quantitative Analysis 42, 167–187.
Barclay, M.J., Dunbar, C.G., Warner, J.B., 1993. Stealth and volatility: which trades move prices? Journal of Financial Economics 34, 281–306.
Barber, B.M., Lee, Y., Liu, Y., Odean, T., 2009. Just how much do individual investors lose by trading? Review of Financial Studies 22, 609–631.
Bamber, L.S., Barron, O.E., Stober, T.L., 1999. Differential interpretations and trading volume. Journal of Financial and Quantitative Analysis 34, 369–386.
Bakshi, G., Cao, C., Chen, Z., 2000. Do call prices and the underlying stocks always move in the same direction? Review of Financial Studies 13, 549–584.
Beber, A., Caglio, C., 2004. Order submission strategies and information: empirical evidence from the NYSE. In: Working Paper. University of Lausanne.
Black, F., 1975. Fact and fantasy in the use of options. Financial Analysts Journal 31, 36–41.
Blau, B.M., Van Ness, B.F., Van Ness, R.A., 2009. Intraday stealth trading: which traders move prices during periods of high volume? Journal of Financial Research 32, 1–21.
Bloomfield, R., O'Hara, M., Saar, G., 2005. The 'make or take' decision in an electronic market: evidence on the evolution of liquidity. Journal of Financial Economics 75, 165–199.
Cao, C., Chen, Z., Griffin, J.M., 2005. The information content of options volume prior to takeovers. Journal of Business 78, 1073–1109.
Chakravarty, S., 2001. Stealth-trading: which traders' trades move stock prices? Journal of Financial Economics 61, 289–307.
Chakravarty, S., Gulen, H., Mayhew, S., 2004. Informed trading in stock and options markets. Journal of Finance 59, 1235–1257.
Chan, K.C., Chang, Y., Lung, P.P., 2009. Informed trading under different market conditions and moneyness: evidence from TXO options. Pacific-Basin Finance Journal 17, 189–208.
Chang, C.C., Hsieh, P.F., Lai, H.N., 2009. Do informed options investors predict stock returns? Evidence from the Taiwan stock exchange. Journal of Banking and Finance 33, 757–764.

Chang, C.C., Hsieh, P.F., Lai, H.N., 2013. The price impact of options and futures volume in after-hours stock market trading. Pacific-Basin Finance Journal 21, 984–1007.
Chaput, J.S., Ederington, L.H., 2005. Volatility trade design. Journal of Futures Markets 25, 243–279.
Chen, C.X., Rhee, S.G., 2010. Short sales and speed of price adjustment: evidence from the Hong Kong stock market. Journal of Banking and Finance 34, 471–483.
Chordia, T., Swaminathan, B., 2000. Trading volume and cross-autocorrelations in stock returns. Journal of Finance 55, 913–935.
Chou, R.K., Wang, Y.Y., 2009. Strategic order splitting, order choice and aggressiveness: evidence from the Taiwan futures exchange. Journal of Futures Markets 29, 1102–1129.
Copeland, T.E., 1976. A model of asset trading under the assumption of sequential information arrival. Journal of Finance 31, 1149–1168.
Cornell, B., Sirri, E.R., 1992. The reaction of investors and stock prices to insider trading. Journal of Finance 47, 1031–1059.
Danielsen, B.R., Sorescu, S.M., 2001. Why do options introductions depress stock prices? A study of diminishing short sale constraints. Journal of Financial and Quantitative Analysis 36, 451–484.
Easley, D., O'Hara, M., 1987. Price, trade size and information in securities markets. Journal of Financial Economics 19, 69–90.
Easley, D., O'Hara, M., Srinivas, P.S., 1998. Option volume and stock prices: evidence on where informed traders trade. Journal of Finance 53, 431–465.
Figlewski, S., Webb, G.P., 1993. Options, short sales and market completeness. Journal of Finance 48, 761–777.
Fleming, J., Ostdiek, B., Whaley, R.E., 1996. Trading costs and the relative rate of price discovery in stock, futures and options markets. Journal of Futures Markets 16, 353–387.
Frino, A., Johnstone, D., Zheng, H., 2004. The propensity for local traders in futures markets to ride losses: evidence of irrational or rational behavior? Journal of Banking and Finance 28, 353–372.
Glosten, L.R., 1994. Is the electronic open limit order book inevitable? The Journal of Finance 49, 1127–1161.
Grinblatt, M., Keloharju, M., 2000. The investment behavior and performance of various investor types: a study of Finland's unique dataset. Journal of Financial Economics 55, 43–67.
Harris, L., 1993. The winners and losers of the zero-sum game: the origins of trading profits, price efficiency and market liquidity. In: Working Paper. University of Southern California.
Han, B., Lee, Y.T., Liu, Y.J., 2009. Investor trading behavior and performance: evidence from Taiwan stock index options. In: McCombs Research Paper Series, No. Fin-06-09.
Hameed, A., Kang, W., Viswanathan, S., 2010. Stock market declines and liquidity. Journal of Finance 65, 257–293.
Johnson, T.L., So, E.C., 2012. The option to stock volume ratio and future returns. Journal of Financial Economics 106, 262–286.
Kaul, G., Nimalendran, M., Zhang, D., 2004. Informed trading and options spreads. In: Working Paper. University of Michigan.
Kaniel, R., Liu, H., 2006. So what orders do informed traders use? Journal of Business 79, 1867–1913.
Kang, J., Park, H.J., 2008. The information content of net buying pressure: evidence from the KOSPI 200 index option market. Journal of Financial Markets 11, 36–56.
Kim, H., Ryu, D., 2012. Which trader's order-splitting strategy is effective? The case of an index options market. Applied Economics Letters 19, 1683–1692.
Kim, O., Verrecchia, R.E., 1991. Market liquidity and volume around earnings announcements. Journal of Accounting and Economics 17, 41–67.
Kyle, A.S., 1985. Continuous auctions and insider trading. Econometrica 53, 1315–1335.
Lee, C.M.C., Ready, M.J., 1991. Inferring trade direction from intraday data. Journal of Finance 46, 733–746.
Lee, K.H., Wang, S.F., 2012. Are foreign short-sellers to blame? Evidence from daily short-selling in Korea stock exchange. In: Working Paper. SSRN.
Ni, S.X., Pan, J., PoteshmanF A.M., 2008. Volatility information trading in the options market. Journal of Finance 63, 1059–1091.
Pan, J., Poteshman, A., 2006. The information in option volume for future stock prices. Review of financial studies 19, 871–908.
Rock, K., (unpublished manuscript) 1990. The specialists order book and price anomalies. Harvard University.
Roll, R., Schwartz, E., Subrahmanyam, A., 2010. O/S: the relative trading activity in options and stock. Journal of Financial Economics 96, 1–17.
Saffi, P.A.C., Sigurdsson, K., 2011. Price efficiency and short selling. Review of Financial Studies 24, 821–852.
Schlag, C., Stoll, H., 2005. Price impacts of options volume. Journal of Financial Markets 8, 69–87.