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期末報告

由週選擇權建立之平價誤差是否亦蘊含波動訊息交易之資訊內涵？

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中 文 摘 要 ： 本研究的目的在探究短期選擇權契約-週選擇契約的訊息發現能力。由於近期的研究已佐證標準契約(如：月選擇權契約)的價格包含訊息交易者之私有訊息(private information)，得做為預測價格報酬及波動度之因子。然而近年推出的週選擇權，因具有低成本及低風險的特性使得成交量與日俱增，因此本文推測波動度的訊息交易者可能會以週選擇權做為交易私訊的標的。換言之，週選擇權價格可能包含預測現貨市場波動度的訊息內涵。本研究使用買賣權平價模式(put-call parity)產生波動價差(volatility spread)，做為檢視短期選擇權契約是否具有預測資產波動度的訊息代理。本研究的主要貢獻有二，其一由於相關研究為避免契約到期的流動性問題，普遍將距到期日5天至2星期的資料刪除，若短期契約包含重要訊息，那麼上述刪減資料規則可能會產生重要訊息漏損的問題；其二即本研究提供首次探究短期選擇權契約在訊息發現能力之研究，並比較短期契約與標準契約在訊息發現功能的差異。

中文關鍵詞 ： 價格發現、買賣權平價模式、波動價差、交易私訊、週選擇權

英 文 摘 要 ： This study aims to explore the information discovery ability of shorter maturity option contract, weekly option. Recent study have provided evidences to support that the standard option contracts carry the private information in predicting the asset price return as well as the price volatility. Since the weekly option is launched, the short maturity market grows dramatically due to its lower cost and lower risk. Then, this study infers that the informed volatility trader might be attracted to trade their private information with short maturity contract. That is to say the weekly option might play the noticeable role in the information discovery. The deviation of PCP (put-call parity) calculated by implied volatilities, says volatility spreads, and is employed to explore the information content of weekly option in predicting the asset volatility. There are two main contributions of this study, one is that provides the evidence to test whether the important information will be ignored while 5 days to 2 weeks data to maturity are usually be eliminated by most of study while using the standard contracts for avoiding the liquidity problem. Secondly, it is the first study to provide the investigation to compare the information discovery abilities between the shorter contracts, weekly contract, and standard contracts, monthly contract.

英文關鍵詞 ： information discovery, put-call parity, volatility spread, private information, weekly option

Does it exist the Information trading content embedded in the deviation of PCP of weekly option market?

Abstract

This study aims to explore the information discovery ability of shorter maturity option contract, weekly option. Recent study have provided evidences to support that the standard option contracts carry the private information in predicting the asset price return as well as the price volatility. Since the weekly option is launched, the short maturity market grows dramatically due to its lower cost and lower risk. Then, this study infers that the informed volatility trader might be attracted to trade their private information with short maturity contract. That is to say the weekly option might play the noticeable role in the information discovery. The deviation of PCP (put-call parity) calculated by implied volatilities, says volatility spreads, and is employed to explore the information content of weekly option in predicting the asset volatility. There are two main contributions of this study, one is that provides the evidence to test whether the important information will be ignored while 5 days to 2 weeks data to maturity are usually be eliminated by most of study while using the standard contracts for avoiding the liquidity problem. Secondly, it is the first study to provide the investigation to compare the information discovery abilities between the shorter contracts, weekly contract, and standard contracts, monthly contract.

Key words: information discovery, put-call parity, volatility spread, private information, weekly option

中文摘要

本研究的目的在探究短期選擇權契約-週選擇契約的訊息發現能力。由於近期的研究已佐證標準契約(如：月選擇權契約)的價格包含訊息交易者之私有訊息(private information)，得做為預測價格報酬及波動度之因子。然而近年推出的週選擇權，因具有低成本及低風險的特性使得成交量與日俱增，因此本文推測波動度的訊息交易者可能會以週選擇權做為交易私訊的標的。換言之，週選擇權價格可能包含預測現貨市場波動度的訊息內涵。本研究使用買賣權平價模式(put-call parity)產生波動價差(volatility spread)，做為檢視短期選擇權契約是否具有預測資

產波動度的訊息代理。本研究的主要貢獻有二，其一由於相關研究為避免契約到期的流動性問題，普遍將距到期日 5 天至 2 星期的資料刪除，若短期契約包含重要訊息，那麼上述刪減資料規則可能會產生重要訊息漏損的問題；其二即本研究提供首次探究短期選擇權契約在訊息發現能力之研究，並比較短期契約與標準契約在訊息發現功能的差異。

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I. Introduction

Numerous studies conclude that option prices provide the valuable and dominant information in predicting stock price. For evidencing their research, monthly options or longer maturity options are usually employed to explore the contained information. However, the option with less 5 days to 2 weeks to maturity will be largely neglected for avoiding the maturity problem. Currently, the short maturity options like weekly options which provide expiration opportunity every week are experiencing a very strong growth since it is launched in global market. It is rational to expect the traders will be attracted to trade their private information with short maturity options due to its short maturity feature. Chong, Ding, and Tan (2003) suggested a negative relation between maturity and the bid-ask spread; then, it is no surprised that the market is largely dominated by shorter maturity contracts in practical since its lower trading cost and lower risk. Furthermore, the peak of trading volume is usually observed in expiring contracts. Thus, it will be an interest question that would the important information might be omitted negligently while the nearly expiring data is excluded for the standard options.

Private information is one of the information content contained in option price has been evidenced by numerous study (such as Black, 1993; Biais & Hillion, 1994; Brennan & Cao, 1996; Cao, 1999; Easley, O'Hara, & Srinivas, 1998; Grossman, 1988; and John *et al.* 2003). Since the arbitrage opportunity induced by public information revealed by violation of no-arbitrage relation will be arbitraged away quickly, thus the prolonged violation observed in market should be explained by other reasons, one possible explanation is private information (Cremers & Weinbaum, 2010; Easley, *et al.*, 1998; Finucane, 1991). Put call parity (PCP) is one of the no-arbitrage relation largely used to explore the information content carried in option prices. Numerous study conclude that short-lived deviation of PCP which cannot be account as the presence of arbitrage opportunity might be induced by the features of imperfect market such as the dividend payments, short-sale restriction, the asynchronous trading problem, etc.[1] However, recent study argues the market's imperfection cannot completely explain the deviation of put call parity, especially for the apparent and prolonged deviations which still can be observed in practice after control the factors of imperfect market's characteristics. Cremers and Weinbaum (2010) suggested the prolonged violation might induce by informed trading, which is consistent with the conclusion of Easley, O'Hara and Srinivas (1998). The informed traders will trade their private information first in the option market which provides the mechanism to maximize their expected return such as the leverage features and the lower cost, etc. However, the price mechanism will fail to drive the stray price back to theoretical level instantly if the information is not public. That is to say option market should have inferior information content in predicting prices of spot market if the stock price does not respond synchronously to the private information carried by option price.

Recent study evidenced that the presence of informed volatility trading in the option market, such as Chang, Hsieh, & Wang (2010) and Ni, Pan & Poteshman (2008), etc. The findings are consistent with the earlier study of Back (1993) which concluded that the options are uniquely suited to investors with private volatility information. Since the option price can be used as a predictor to forecast the stock price and the information related to stock price if the private information traded in option market which has not reflect on the stock price yet, and the informed volatility trading would tend to trade in option market, that is to say, the option price

[1]See also, e.g., Brenner and Galai(1986), Kamara and Miller (1995), Klemkosky and Resnick (1979, 1980), and Nisbet (1992).

might carry the valued information in predicting the stock price volatility in the futures. Chen, Chung, & Yuan (2014) evidenced the predicting ability on stock price volatility using the TXO monthly contract, and their empirical result in support of the predicting ability on stock volatility using the volatility spread of option price.

Refer to the related study, the information content within option price would be explored using the standard option contracts, such as monthly contracts or quarterly contracts. For avowing the potential liquidity concerns, the option price with less than 5 days to 2 weeks trading days remaining to maturities are excluded from sample of empirical study. However, the shorter contracts like weekly contracts have been introduced in market recent years and the trading volume increase dramatically after they are launched to market. It will emerge an interesting question that whether the informed trading would take place in weekly option market especially for the informed volatility trading since its dominance to liquidity and lower cost. This study is along with the study Chen, *et al.* (2014) which aims to investigate the volatility information content within the deviation of put-call parity using monthly Taiwan index option data, however, this study employ the shorter contract, weekly options, rather than standard contract, like as monthly contracts or quarterly contracts to investigate whether the private volatility information can be explored in weekly option price. This study here are largely complementary since this is the first study to investigate the information discovery role for weekly contract to our best knowledge. There are two main contributions of this study, one is that can be used to judge whether the data filter rule adopted by a lot of study which eliminates the trading day less than 5 days to 2 weeks to maturity will ignore the important information. Secondly, it can be used to compared with the information content within the standard option contracts which might provide a suggestion to which contract will provide more valuable information to investors.

II. Methodology

Along with the study of Chen, et al. (2014), this study further investigate whether the shorter contracts like weekly contracts contain the private information which still does not delivered to spot market yet like as the information role played by standard option contracts like monthly contracts which has been evidenced by recent study. The empirical designation adopted by this study is along with the suggestion of Chen, *et al.*, however, this study here are largely complementary is using the weekly contract to investigate the information content contained in the volatility spread of weekly option. To the best of our knowledge, this is the first study to investigate the information role of weekly contracts.

1. Deviation from put-call parity

Several recent study argue that the d deviations from put-call parity can arise in the presence of market imperfections such as short sales constraints (Lamont & Thaler, 2003; Ofek & Richardson, 2003; and Ofek, Richardson & Whitelaw, 2004), or non-synchronicity (Battalio & Schultz, 2006), however, more and more study agree with that the price are not fully efficient in the model and option prices might deviation from put-call parity due to the informed private trading. Especially for these deviations which cannot arbitrage away instantaneously since the information contained in option price not yet incorporated in stock price. It implied that if the private information can be detected and measured by option trading data, it can be used to predict the stock price and price volatility.

Easley, et al. (1998) who used the deviation of put-call parity as the probability of informed trading (or PIN) to reflect the trading activity of informed traders (see also Amin, Coval, & Seyhun, 2004 and Figlewski & Webb,1993). Cremers and Weinbaum (2010) argued that the deviation of put-call parity are more likely to be observed while the option market has dominant and asymmetric information environment compared with the underlying stock market. Along with the line of Easley, et al (1998) work, Cremers and Weinbaum (2010) applied volatility spread, which is derived from PCP no-arbitrage relation and is defined by the difference in implied volatilities between call and put with the same strike price and the sample expiration, to proxy the probability of informed trading.

The rationale is that the PCP for European options equivalently states that the Black–Scholes (1973) implied volatilities of pairs of call and put options are equal, even if option prices do not conform to the Black–Scholes formula. The difference between call and put implied volatilities thus can be interpreted as deviations from model values. However, in practice, deviations caused by informed trading likely occur for options with different exercise prices. The deviations are calculated as the implied volatility spread between call and put options with the same maturity. The study adopts the method proposed by Cremers and Weinbaum (2010) to define the deviation of PCP as the measure of quantity of information, as illustrated as equation (1), which is the average difference in implied volatility between call and put options across option pair with the same strike prices and maturities and is recognized as 'volatility spread'(VS).

$$\mathrm{VS}_t = IV_t^C - IV_t^P = \sum_{j=1}^{N_t} w_{j,t}(IV_{j,t}^{i,C} - IV_{j,t}^{i,P}) \tag{1}$$

Where j refers to pairs of call and put option with the same exercise price and maturities and only the option pair for which either the call's or put's option interest or bid-price are non-zero are considered as the empirical data; N_t is the number of pair of TXO index options on day t. Finally, options violating the PCP boundary conditions are deleted from the sample.

2. Implied volatility

The estimation of implied volatility is critical in calculating the volatility spread as shown as equation (1). One traditional approach is to derive the volatility implied in the option prices by equating the actual option prices and the Black–Scholes option pricing model (Black & Scholes, 1973) price. However, recent research argues that the lognormal assumption of the underlying asset's return distribution in the Black–Scholes model may lead to material errors if using the B-S implied volatility to forecast the realized volatility. More recent studies attempt to correct the inherent methodological problem in the Black–Scholes model by adding the stochastic volatility jump. However, these models continue to assume that the stochastic component remains locally Gassian, which may not be empirically supported by the real world financial markets. In fact, the predictive power of model-based implied volatility mainly depends on two hypotheses: the absence of arbitrage opportunity and the validity of option pricing model. Thus, even under the null hypothesis of efficient market, the forecasting error of implied volatility still cannot be avoided if the model misspecification error exists.

An alternative approach is the model-free implied volatility process, which extracts the implied volatility from the option's price entirely under the no-arbitrage condition without relying on a specific pricing model. This study adopted the measure proposed by Jiang and Tian (2005, 2007) since most of the related study agree that the Jiang and Tian (2005, 2007) measure is a better method compare with another competitor in calculating the model free implied volatility.

Following the approach of Jiang and Tian (2005, 2007), the model-free implied variance under the assumption of deterministic interest rates is written as equation (2) shown,

$$2\int_{K_{\min}}^{K_{max}} \frac{C(\tau,K)/B(0,\tau)-\max[0,S_0/B(0,\tau)-K]}{K^2}dK \approx \sum_{j=1}^{M}[f(\tau,K_j)+f(\tau,K_{j-1})]\Delta K, \tag{2}$$

Where S_0 and $C(\tau,K)$ are the asset price and option price, respectively. K is the exercise price. τ Denotes the expiration date of option. $B(t,\tau)$ is the time t price of a zero-coupon bound that pays $1 at time τ. $f(\tau,K_i)=[C(\tau,K)/B(0,\tau)-\max(0,S_0/B(0,\tau)-K)]/K_i^2$, $\Delta K = (K_{\max}–K_{\min})/M$, and $K_{\mathrm{i}} = K_{\min} + \mathrm{i}\Delta K$ for $0 \le \mathrm{i} \le M$. The truncation interval $[K_{\min}, K_{\max}]$ denotes the range of available exercise prices, in which $K_{\min}$ and $K_{\max}$ are referred as left and right truncation points, respectively. And for the purpose of avoiding the bid–ask bounce problem, the midpoint of the quote rather than the transaction price is used to compute the implied volatility (Bakshi, Cao, & Chen, 1997, 2000).

3. Positive and negative volatility signal

Since the volatility spread do not represent the unexploited arbitrage opportunity but can be viewed as proxies for price pressure induced by private information if the investor with private volatility information to trade in option first (Cremers and Weinbaum, 2010), thus the volatility spread may carry the private information including the forecasting in volatility direction of informed trader. Chen, *et al.* (2014) suggested the volatility spread can be divided into two signals, one is positive volatility signal, and the other is negative signal. Contribute to the separating the private information represented by volatility spread into positive and negative signal, volatility spread can further be used as the indicator to forecast the price volatility of stock market evidence from Chen, *et al.*, (2014).

This study adopted the empirical study framework proposed by Chen, *et al*. (2014) to divide the volatility spread into positive or negative signal. In practice, straddles, strangles, and an option/futures combination are the three most commonly used volatility trading strategies (Chaput & Ederington, 2005). This suggests that informed investors who are privy to a positive (negative) volatility information usually conduct their volatility trades by long (short) straddles, strangles, or an option/futures combination, that is, a long (short) position for a call or put option and a short (long) position for futures. However, both in the model of straddles and strangles strategies, it requires that investors simultaneously buy (sell) both call and put options with different exercise prices to construct an approximately delta-neutral option portfolio to trade their positive (negative) volatility information. It tends to drive both the implied volatilities of call and put options to the relatively higher (and lower) level rather than to produce a larger volatility spread. However, the model of buying a call (put) in the option/futures strategy which is a trade that carries positive volatility information may result in the raising of a call (put) price relative to a put (call) price. Similarly, selling a call (put) that conveys negative volatility information decreases a call (put) price relative to a put (call) price. These trades widen the range of the relative position of call and put prices. Under the measure of deviations, a widened volatility spread may be generated by volatility trading based on an option/futures strategy rather than volatility trades with a long (short) straddle and strangle. Secondly, the relative study argued that the volatility trades through straddles and strangles only account for a small fraction of option trading volume (Chang et al., 2010; Lakonishok, Lee, Pearson, & Poteshman, 2007), it implies that the dominant role of volatility trading with an option/futures strategy suggests that the informed volatility trading often results in a widened volatility spread. This widened volatility spread reflects private volatility information.

To trade the positive volatility signal, the informed volatility traders adopt the one-sided strategy of buying a call or buying a put. Such trading will raise the implied volatility of either calls (V_c) or puts (V_p). Then it drives the deviation of PCP using V_c and V_p strays from the prior level of average implied volatility of call and put options denoted by OV. That is to say, the absolute value of VS will be enlarged due to positive volatility trading, we denote it as VS_b as shown as Eq(3). Next, it needs to further recognize what strategy, buying call or buying put, is adopted by informed trader. If the trader adopts the buying call strategy, it will raise Vc relative Vp and makes Vc deviates more from OV_{t-1}, like it is shown as $V_c > V_p$ and $|V_{c,t}-OV_{t-1}|>|V_{p,t}-OV_{t-1}|$, then, it will be recognized as VS^C_b mean the enlarged VS is induced by the buying call strategy with positive information, as shown as eq(3).

$$\mathrm{VS}_b^c = \begin{cases} \left|V_{c,t} - V_{p,t}\right|, if\ V_{c,t} > V_{p,t}\ and \left|V_{c,t} > OV_{t-1}\right| > \left|V_{p,t} > OV_{t-1}\right| \\ 0, \quad \text{if otherwise} \end{cases} \tag{3}$$

Where $V_{c,t}$ and $V_{p,t}$ denote the implied volatilities of calls and puts on day *t*, respectively. OV_{t-1} denotes the level of PCP on day *t*–1, which is the average of V_c and V_p on day *t*–1.

On the other hand, in the case of $V_c < V_p$ and $|V_{c,t}-OV_{t-1}|<|V_{p,t}-OV_{t-1}|$, is should be recognized as the results of buying put strategy denoted as VS^P_b, as shown as Eq(4).

$$\mathrm{VS}_b^p = \begin{cases} \left|V_{c,t} - V_{p,t}\right|, if\ V_{c,t} < V_{p,t}\ and \left|V_{c,t} > OV_{t-1}\right| < \left|V_{p,t} > OV_{t-1}\right| \\ 0, \quad \text{if otherwise} \end{cases} \tag{4}$$

The negative volatility signals are also obtained by abstracting them separately from call and put options. Volatility trades through selling a call lessen V_c relative to V_p, and drive V_c to deviate more from OV_{t-1}. The quantity of negative private information on day *t* implicit in calls is quantified as

$$\mathrm{VS}_s^c = \begin{cases} \left|V_{c,t} - V_{p,t}\right|, if\ V_{c,t} < V_{p,t}\ and\ \left|V_{c,t} - OV_{t-1}\right| > \left|V_{p,t} - OV_{t-1}\right| \\ 0, \quad \text{if otherwise} \end{cases} \tag{5}$$

Likewise, the quantity of negative private information on day *t* implicit in puts is quantified as

$$\mathrm{VS}_s^p = \begin{cases} \left|V_{c,t} - V_{p,t}\right|, if\ V_{c,t} > V_{p,t}\ and\ \left|V_{c,t} - OV_{t-1}\right| < \left|V_{p,t} - OV_{t-1}\right| \\ 0, \quad \text{if otherwise} \end{cases} \tag{6}$$

Furthermore, this study infer that the absolute deviation of VS from its median , which is denoted as VSM, cam better reflect the quantity of volatility information rather than the level of VS. Beside the VS which are employed as the proxy variable of volatility information, there are 4 more proxy of volatility information variable including the positive volatility information implicit in call and put denoted as VSM^c_b, VSM^p_b respectively as well as the negative volatility information implicit in call and put, which says VSM^c_s and VSM^p_s.

4. The explaining ability of VS or VSM on price volatility

If informed investors do trade on private volatility information in the option market first, their private information would be subsequently reflected in the spot market. We can expect that an increase in subsequent volatility will follow volatility spreads with a positive signal (VS_b and VSM_b), and a decrease in subsequent volatility will follow volatility spreads with a negative signal (VS_s and VSM_s). Equation (7) is employed for catching the explaining ability of VS on the realized volatility in future which is specified as

$$\mathrm{RV}_t = \alpha + \beta_1 VS_{b,t-j} + \beta_2 VS_{s,t-j} + \beta_3 \Delta OV_{t-j} + \beta_4 IV_{t-1} + \varepsilon_t \tag{7}$$

Where RV_t denotes the realized volatility of underlying index on day *t*, which is calculated as the difference of closing prices for two consecutive trading days divided by the closing price of previous trading day[2]. VS_b is the volatility spread with positive volatility information embedded in both call and put options, VS^c_b and VS^p_b, respectively. VS_s denotes the volatility spread with negative volatility information involving VS^c_s and VS^p_s.

Two control variables are considered in Equation (7). IV_{t-1} denotes the implied volatility of the whole option market on day *t*–1, which the literature, in general, finds to be best predictor for future volatility and is usually provided by the option exchange market. This variable controls for publicly available information already contained in the option prices. However, above all, IV_{t-1} is calculated using the standard option contract, that says the monthly option contract, it is usually neglect the trading data if the option is going to be matured in a week for avoiding the maturing effect. Thus, the control variable of IV_{t-1} can help us to investigate whether it still has extra information contained in the implied volatility of shorter option contract if the model has considered the explaining ability of standard option contract. ΔOV_{t-j} controls the effect of straddle and strangles trades on day *t*–*j* for future volatility, where OV is the average implied volatility of call and put options.

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[2] $RV_t = \left(\frac{\mathrm{HP}_t - \mathrm{LP}_t}{\mathrm{S}_t}\right) \times 252^{0.5}$, in which HP_t, LP_t, S_t are the highest, lowest, and closing price of market index at day t.

The regression in Equation (7) is estimated separately for different values of j, from 1 to k, to capture the potential predictive power of volatility spreads for future realized volatility. In addition, the asymptotic t-statistics of estimated parameters are calculated by using Newey and West's (1987) autocorrelation correction.

Unlike investors with positive information about asset prices who only choose to buy calls, an investor with a positive volatility signal can buy either calls or puts due to the positive values of Vega in both. The calls and puts can thus carry positive information about subsequent volatility. To further test whether the directional volatility information is reflected in both calls and puts, a predictive regression of volatility spreads with the positive and negative information implicit separately in calls and puts on future volatility is run as

$$\begin{aligned} \mathrm{RV}_t = \alpha + \beta_1 VS^c_{b,t-j} + \beta_2 VS^p_{b,t-j} VS_{s,t-j} + \beta_3 VS^c_{s,t-j} + \beta_4 VS^p_{s,t-j} + \beta_5 \varDelta OV_{t-j} \\ + \beta_6 IV_{t-1} + \varepsilon_t \end{aligned} \tag{8}$$

Where VS^c_b and VS^p_b (VS^c_s and VS^p_s) denote the volatility spreads with positive (negative) volatility information implicit separately in calls and puts.

Furthermore, this study infers that the change of volatility spread (VSM) might be used on reflecting the volatility trading information better than the level of volatility spread (VS). Thus variable of VS in both equation (7) and (8) is replaced by the VSM which is defined as the absolute deviation of from the median as the proxy variable of volatility trading information.

Respond to the purposes of this study, it tries to investigate whether the shorter maturity contract carries valuable information in predicting the asset volatility. The hypothesis test as H_0 shown as follow is used to investigate the statistical significance of the regression coefficients for volatility spreads including VS^c and VS^p. If βi is different from zero while H_0 is rejected in statistical, it provides the evidence to support our inference that the weekly option carry the private information in predicting the asset volatility and it also evidences the informed volatility trading activity of weekly option.

H_0: $\beta i=0$ H_1:$\beta i\neq 0$

Where i=1, 2,, 3, 4, respectively.

Moreover, the second purpose of this study is to investigate if there is any extra information content contained in weekly contracts while the explanation of monthly contract has considered.

In conclusion, there are two main contributions of this study, one is that provides the evidence to test whether the important information will be ignored while 5 days to 2 weeks data to maturity are usually be eliminated by most of study while using the standard contracts for avoiding the liquidity problem. Secondly, it is the first study to provide the investigation to compare the information discovery abilities between the shorter contracts, weekly contract, and standard contracts, monthly contract.

III. Empirical Study

1. Data Description

Taiwan index option written on Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) launched by Taiwan Futures Exchange (TAIFEX) is one of most liquid index option in the world[3]. For satisfying the needs of short-term trader, TAIFEX launched the weekly Taiwan Index Option (TXO) in NOV. 2012. The trading volume of TXO weekly option increases dramatically recent year induce TXO weekly option has become the largest weekly index option contract in the world reported by TAIFEX in 2015. This is the first reason why this study employs TXO (Taiwan Index Option) weekly option contracts as the empirical data for shedding light of investigating the information discovery ability of shorter maturity contracts. Secondly, it has provided strong evidence to support that the volatility information trading exists in TXO market according to the empirical result of Change *et al.*(2010), and Chen, *et al.*(2015). Furthermore, TXO market provides inherent superiority since there is no alternative derivative except for option to trade volatility, thus the abnormal change on the volatility implied in option price can clearly infer that is probably resulted by the volatility trading.

The daily data of TXO weekly option covered from Dec-26-2013 to Jul-13-2016 provided by Taiwan Economic Journal (TEJ) Database are employed by this study. Secondly, the TAIFEX's VIX which is provided by TAIFEX of using TXO monthly option are used as the control variable for extracting the information contained in the shorter maturity options. As for the realized volatility, which is calculated by daily high, low, and closing prices of Taiwan stock index are obtained from TEJ database. In total, 244 daily trading data are obtained to implement the empirical work.

[3] According to the report of World Federation of Exchange in 2010, TXO is rank the fifth most frequency traded index option.

2. Volatility Spread and realized volatility

For exploring the information on predicting the future volatility contained in the shorter maturity option, the implied volatility derived from TXO weekly option should be calculated first. Model free model suggested by Jiang and Tian (2007, 2007) are employed to calculate the implied volatility of TXO weekly option by using the midpoint of the quote rather than the transaction price for avoiding the bid-ask bounce problem (Bakshi, Cao, and Chen, 1997, 2000). Since the purpose of this study is investigate whether the information would be neglected arbitrarily if the information indeed contained in the shorter option contract but the data filter mechanism usually is employed by most of study for eliminating the trading data which is expiring in a week, all trading data will take into account in this study except for these following 2 conditions, which are if option with quote price less than 0.1, the minimum tick size and the option violating the PCP boundary condition should be excluded from the sample data.

Secondly, since the volatility trading will make either call's or put's implied volatility deviate from each other if the trader only use one of call or put option to trade their private information, thus, the volatility spread using PCP parity (denoted as VS thereafter) defined as the difference between the implied volatilities of call and put options can be viewed as the signal of the volatility trading information. Follow the definition of Chen, *et al.* (2015), the VS can be classified into call (put) signal if the spread is induced by call's (put's) implied volatility deviate from put's(call's) implied volatility as well as the level of PCP on previous period. As result, the deviation of volatility spread (denoted as VSM) which is defined as the deviation of volatility from its median can also be classified into 4 variables of volatility information.

As for the realized volatility, the daily high, low, and closing price of spot market index is used to calculate (defined as the footnote [2] shown). Figure 1 demonstrates the implied volatility calculated from TXO call or put weekly option denoted as IVc and IVp respectively as well as the realized volatility. Moreover, it also shown the pattern of change volatility spread defined by the deviation of VS from it median, denoted as VSM on figure 2 since it infers that VSM might catch the volatility information better than the level of volatility spread denoted as VS. The VSM as well as VS can be classified into positive volatility signal and negative volatility signal, and each signal still can be further subdivided according to the information which is reflected from call or put option. Figure 2 has shown the positive volatility signal seems more volatile than the negative signal which is consistent with demonstration of Table 1 which illustrated the basic statistics descriptions for volatility spread variables. It also shown the volatility spread which is reflected on the call option will be more volatility than put option.

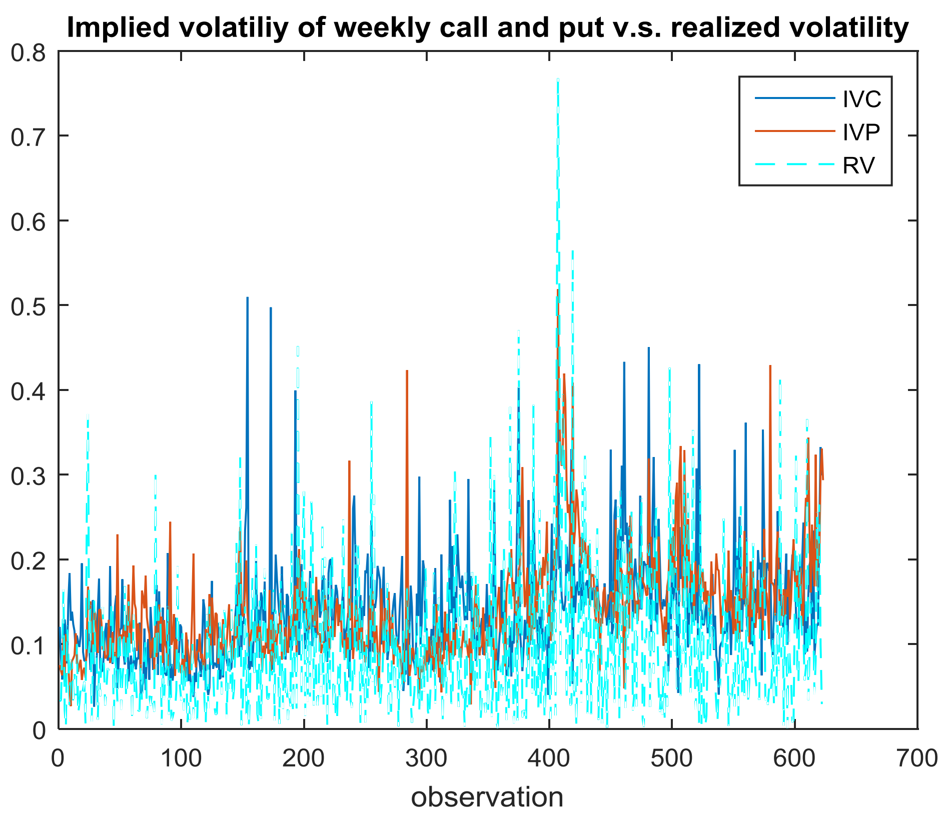

Figure 1 Implied volatility of weekly call and put option versus realized

volatility

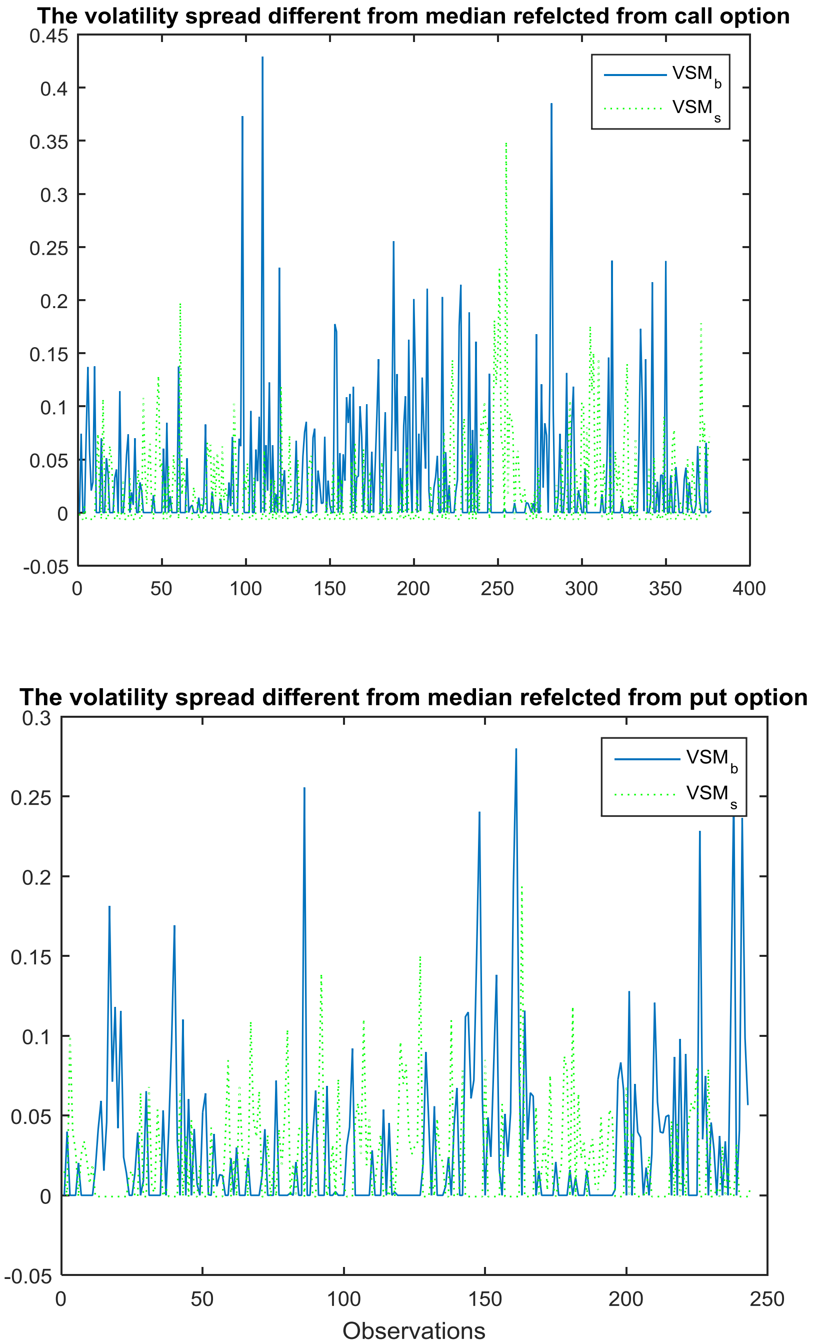

Figure 2 the volatility spread different from median reflected on the call and put respectively

Besides that, it has shown VSM is more volatility than VS, it provides the evidence to support the VSM is better to be used as the proxy variable to catch the volatility trading information, it means the VSM will explain the realized volatility better thank VS.

3. Control variables

There are 2 control variables are employed by this study, one is the change of average implied volatility of call and put, denoted as ΔOV, the other is the information embedded in the implied volatility of standard option, namely monthly contract, denoted as Taifex's VIX. Because the straddles and strangle trades are more likely to raise or lessen both the implied volatilities of calls and puts and drives them to deviate more from prior level of PCP, therefore, it employs ΔOV which is the percentage change of level of PCP to be used to gauge the information released by straddle and strangle trade. As for Taifex's VIX which is provided by TAIFEX is used for catch the extra information which is only embedded in weekly option but monthly contract. If the explaining ability of weekly VSM is significant after control ΔOV and IV, it means it still carry significant information in shorter contract however it is usually neglected by most of study.

Table 1 Summary Statistics of Common Variables

	mean	Std	median	skewness	kurtosis	min	max
RV	0.1005	0.0931	0.0745	2.0584	10.015	0.0003	0.7677
VS^c_b	0.0531	0.0474	0.0429	2.2601	11.7324	0.0001	0.3554
VS^p_b	0.0432	0.0337	0.0364	1.5054	6.1162	0.0016	0.1943
VS^c_s	0.0628	0.0577	0.0457	1.8573	6.4861	0.0000	0.2801
VS^p_s	0.1475	0.0418	0.1417	1.2762	5.5279	0.0837	0.3822
VSM^c_b	0.0725	0.0719	0.0544	2.0610	8.7628	0.0003	0.4292
VSM^p_b	0.0316	0.0516	0.0002	2.4385	9.7453	-0.0000	0.2801
VSM^c_s	0.0221	0.0436	0	2.5885	13.5867	-0.0063	0.3492
VSM^p_s	0.0208	.0321	0	1.9661	7.6726	-0.0008	0.1935
ΔOV	0.0003	0.0469	-0.0012	-0.0400	13.643	-0.2986	0.2919
IV	0.1443	0.0501	0.1319	1.7770	8.9146	0.0494	0.4929

4. The explaining ability of weekly VSM

Equation (8) is employed for exploring the explanation of VSM of weekly contract. For considering the information contained in the lag periods, 2 lag orders of VSM are considered as the independent variables. In addition, the asymptotic t-statistics of estimated parameters are calculated by using Newey and West’s (1987) autocorrelation correction. According to Table 2, VSM can predict the realized volatility of next trading day very well except for VSM^c_b without considering the explanation of monthly Taifex VIX. However, if it considers the information contained in the Taifex VIX which is calculated from monthly contract, the explaining ability of weekly VSM decrease sharply, it implied most of information contained in weekly VSM is covered by Taifex VIX. However, the explaining ability contained in VSM^p_s is still significant with the significant level of 10%, it implied that weekly VSM still carry the information to realized volatility which is uncovered by Taifex VIX. If it further considers the 2nd lag order information of VSM, it is surprising to find that the 2nd lag order of VSM^c_b carry significant explanation to predict the realized volatility though Taifex VIX still explain most part of the predicting information to the realized volatility.

In sum, the monthly option contract still carry most part of predicting information to realized volatility, and furthermore, the most of information contained in weekly VSM is covered by Taifex VIX. However, it still has valuable extra information contained in weekly VSM to predict volatility which is not covered by Taifex VIX. It implied that the volatility information trader might trade their private information using weekly option contract while it evidences on Taiwan market, thus these valuable information might be neglected due to the trading data which is expiring in a week usually be exclude from empirical data by most of study.

Table 2 the explaining ability for VSM

	Lag=1		Lag=2	
intercept	0.150**	0.0079	0.150***	0.008
	(38.32)	(0.42)	(38.81)	(0.42)
$\Delta OV_{(lag=1)}$	0.086	-0.021	0.145	0.026
	(0.58)	(-0.21)	(0.79)	(0.23)
$VSM^c_{b(lag=1)}$	0.072	0.061	0.058	0.048
	(0.66)	(0.68)	(0.52)	(0.54)
$VSM^c_{s(lag=1)}$	0.339**	-0.037	0.310***	-0.006
	(2.52)	(-0.34)	(2.31)	(-0.05)
$VSM^p_{b(lag=1)}$	0.243**	0.040	0.190	0.045
	(1.96)	(0.42)	(1.66)	(0.47)
$VSM^p_{s(lag=1)}$	0.353***	0.040*	0.361***	0.135
	(2.30)	(1.28)	(2.20)	(1.02)
Taifex VIX	-	0.962***	-	0.959***

	Lag=1		Lag=2	
		(6.91)		(6.52)
$VSM^{c}_{b(lag=2)}$	-	-	0.155***	0.959**
			(2.15)	(1.71)
$VSM^{c}_{s(lag=2)}$	-	-	0.311***	0.028
			(2.45)	(0.20)
$VSM^{p}_{b(lag=2)}$	-	-	0.095	-0.062
			(1.07)	(-0.81)
$VSM^{p}_{s(lag=2)}$	-	-	0.005	-0.093
			(0.03)	(-0.64)
R^2	1.7%	21.03%	2.92%	20.95%

Note: * mean the t value is significant with significant level of 10%. **, and *** represent the t value is significant with significant level of 5%, and 1% respectively. The asymptotic t-statistics of estimated parameters are calculated by using Newey and West's (1987) autocorrelation corrction

IV Conclusion

This study is trying to explore whether the private volatility information can be observed in shorter weekly option contract or it only can be carried by standard monthly contract. It evidences on Taiwan option market due to its dramatically rapid growth rate recent year. Secondly, it still has not the volatility derivatives to trade the private information of volatility, therefore, the deviation of implied volatility between of call and of put, namely volatility spread, can define clearly it is induce by the volatility trading.

The volatility spread which is derived from PCP followed the definition of Chen *et al.* (2014) are employed to be the explaining variable to predict the realized volatility. After control the explanation of Taifex VIX which is derived from monthly option contract, it shows the weekly volatility spread still carry significant explanation to the realized volatility. It implied that the volatility trading indeed exists and can be observed in shorter option contract, however, it is possible be neglected if the trading data is usually excluded from sample data. In sum, this study provides the evidence to support the predictability of weekly option contract after controlling the possible factors which are expected having the explain ability to realized volatility including Taifex VIX, and ∆OV. The result supports the inference of volatility trading can be observed in shorter option contract.

Reference

1. Alizadeh, S., Brandt, M. W., & Diebold, F. X. (2002). Range-based estimation of stochastic volatility models. Journal of Finance, 57.
2. Amin, K., Coval, J., & Seyhun, N. (2004). Index option prices and stock market momentum. Journal of Business, 77, 835–873.
3. Andersen, T. G. (1996). Return volatility and trading volume: An information flow interpretation of stochastic volatility. Journal of Finance, 51, 169–204.
4. Back, K. (1993). Asymmetric information and options. Review of Financial Studies, 6, 435–472.
5. Bakshi, G., Cao, C., & Chen, Z. (1997). Empirical performance of alternative option pricing models. Journal of Finance, 52, 2003–2049.
6. Bakshi, G., Cao, C., & Chen, Z. (2000). Pricing and hedging long-term options. Journal of Econometrics, 94, 277–318.
7. Black, F., & Scholes, M. S. (1973). The pricing of options and corporate liabilities. Journal of Political Economy, 81, 637–654.
8. Chang, C.-C., Hsieh, P.-F., & Wang, Y.-H. (2010). Information content of options trading volume for future volatility: Evidence from the Taiwan options market. Journal of Banking and Finance, 34, 174–183.
9. Chaput, J. S., & Ederington, L. H. (2005). Volatility trade design. Journal of Futures Markets, 25, 243–279.

10. Chen, C.H. Chung, Huimin and Yuan, S.F.(2014) "Deviations From Put-Call Parity and Volatility Prediction: Evidence From The Taiwan Index Option Market ", Journal of Futures Market, 34(12),1122-1145
11. Chen, X., & Ghysels, E. (2010). News—good or bad—and its impact on volatility predictions over multiple horizons. Review of Financial Studies, 24, 46–81.

12. Cremers, Martijn and D. Weinbaum (2010), "Deviations from Put-Call Parity and Stock Return Predictability," *Journal of Financial and Quantitative Analysis*, Vol. 45(2), pp.335-367.
13. Easley, D., O'Hara, M., and Srinivas, P. (1998). Option volume and stock prices: Evidence on where informed traders trade. Journal of Finance, 53, 431–465.

14. Figlewski, S., and Webb, G. (1993). Options, short sales, and market completeness. Journal of Finance, 48, 761–777.

15. Finucane, T. J. (1991). Put–call parity and expected returns. Journal of Financial and Quantitative Analysis, 26, 445–457.

16. Jiang, G., and Tian, Y. (2005). Model-free implied volatility and its information content. Review of Financial Studies, 18, 1305–1342.

17. Jiang, G., and Tian, Y. (2007). Extracting model-free volatility from option prices: An examination of the VIX index. Journal of Derivatives, 14, 1–26.

18. Klemkosky, R. C., and Resnick, B. G. (1980). An ex ante analysis of put–call parity. Journal of Financial Economics, 8, 363–378.

19. Lakonishok, J., Lee, I., Pearson, N. D., and Poteshman, A. M. (2007). Option market activity. Review of Financial Studies, 20, 813–857.

20. Lamont, O., and Thaler, R. (2003). Can the market add and subtract? Mispricing in tech stock carve-outs. Journal of Political Economy, 111, 227–268.

21. Newey, W. K., and West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance martrix. Econometrica, 55, 703–708.

22. Ni, S. X., Pan, J., and Poteshman, A. M. (2008). Volatility information trading in the option market. Journal of Finance, 63, 1059–1091.

23. Nisbet, M. (1992). Put–call parity theory and an empirical test of the efficiency of the London traded options market. Journal of Banking and Finance, 16, 381–403.

24. Ofek, E., and Richardson, M. (2003). Dotcom Mania: The rise and fall of internet stock prices. Journal of Finance, 58, 1113–1136.

25. Ofek, E., Richardson, M., and Whitelaw, R. (2004). Limited arbitrage and short sales restrictions: Evidence from the options markets. Journal of Financial Economics, 74, 305–342.

科技部補助計畫衍生研發成果推廣資料表

日期:2016/10/27

<table>
<tr><td rowspan="3">科技部補助計畫</td><td colspan="2">計畫名稱: 由週選擇權建立之平價誤差是否亦蘊含波動訊息交易之資訊內涵？</td></tr>
<tr><td colspan="2">計畫主持人: 袁淑芳</td></tr>
<tr><td>計畫編號: 104-2410-H-343-002-</td><td>學門領域: 財務</td></tr>
<tr><td colspan="3">無研發成果推廣資料</td></tr>
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104年度專題研究計畫成果彙整表

計畫主持人：袁淑芳					**計畫編號：**104-2410-H-343-002-		
計畫名稱：由週選擇權建立之平價誤差是否亦蘊含波動訊息交易之資訊內涵？							
成果項目					量化	單位	質化 （說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文			0	篇	
		研討會論文			0		
		專書			0	本	
		專書論文			0	章	
		技術報告			0	篇	
		其他			0	篇	
	智慧財產權及成果	專利權	發明專利	申請中	0	件	
				已獲得	0		
			新型/設計專利		0		
		商標權			0		
		營業秘密			0		
		積體電路電路布局權			0		
		著作權			0		
		品種權			0		
		其他			0		
	技術移轉	件數			0	件	
		收入			0	千元	
國外	學術性論文	期刊論文			0	篇	
		研討會論文			0		
		專書			0	本	
		專書論文			0	章	
		技術報告			0	篇	
		其他			1	篇	working paper. 預計投入國際研討會及期刊。
	智慧財產權及成果	專利權	發明專利	申請中	0	件	
				已獲得	0		
			新型/設計專利		0		
		商標權			0		
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		積體電路電路布局權			0		
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參與計畫人力	本國籍	大專生	0	人次	
		碩士生	2		兼任研究助理。
		博士生	0		
		博士後研究員	0		
		專任助理	0		
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士後研究員	0		
		專任助理	0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）			無		

科技部補助專題研究計畫成果自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現（簡要敘述成果是否具有政策應用參考價值及具影響公共利益之重大發現）或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以100字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形（請於其他欄註明專利及技轉之證號、合約、申請及洽談等詳細資訊）

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3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性，以500字為限）

本研究的目的在探究短期選擇權契約-週選擇契約的訊息發現能力。本文推測波動度的訊息交易者可能會以週選擇權做為交易私訊的標的。換言之，週選擇權價格可能包含預測現貨市場波動度的訊息內涵。實證結果顯示，在納入標準契約所產生之VIX, 由週選擇權所計算的波動價差(VOlatility spread)力對未來波動度仍具有統計上顯著的解釋力。該實證結果佐證短期契約確實存在波動交易者之私訊內涵，另一方面，若考慮換約效果而刪除週內到期資料可能產生訊息漏損的問題。

4. 主要發現

本研究具有政策應用參考價值：■否 □是，建議提供機關

（勾選「是」者，請列舉建議可提供施政參考之業務主管機關）

本研究具影響公共利益之重大發現：■否 □是

說明：（以150字為限）