No. 1909 [EN]

IMI Working Paper

Put-Call Ratio Predictability of the 50ETF Option

Gang Jianhua, Zhao Yang and Ma Xinchen

INTERNATIONAL MONETARY INSTITUTE

For further information, please visit
http://www.imi.org.cn/en/

Weibo WeChat

IMI Working Paper No. 1909 [EN]

Put-Call Ratio Predictability of the 50ETF Option *

By **GANG JIANHUA, ZHAO YANG and MA XINCHEN***

July 2019

Abstract

This paper investigates the predictive power of the put-call-ratio (PCR) implied by China's 50ETF option on the 50ETF return and its variance. By using simple partitional regressions, the relationship between the PCRs and 50ETF returns are tested. This study conducts tests and their robustness based on different horizons, market conditions, moneyness status and time to maturity. Empirical results indicate that the PCR is a strong forward-looking indicator of the variance of 50ETF return. A robust and negative correlation is detected. A significant linear correlation between the PCR and 50ETF return only exists during the market crash. This study shows evidence that the PCR as seen in common trading practices may be misused and indicates a potential way of using it.

JEL Classification: E32; G11; G14; G15

Keywords: 50ETF, option, put-call ratio, partitional OLS

* This paper is published in Economic and Political Studies: Vol.7, No.2.

* Gang Jianhua, Research Fellow of IMI, School of Finance, Renmin University of China; Zhao Yang, International College, Renmin University of China; Ma Xinchen, Hanqing Advanced Institute of Economics and Finance, Renmin University of China. Corresponding author: xinchen@ruc.edu.cn.

1. Introduction

Among world's Top-20 most-traded index derivatives in 2015, index options occupied 8 seats, in which 4 seats belonged to the ETF-index options[1]. And in 2016, index options accounted for 12 seats, in which ETF-index still took 4 seats among them. Therefore, the ETF-index option is playing a crucial role in the market of financial derivatives. In November 1998, the first ETF option tracking MidCap SPDRs was listed in US. And soon afterward, a number of ETF options tracking major indices were listed worldwide. On February 9th, 2015, an index option on the SSE 50ETF[2] was introduced in China and listed in the Shanghai Stock Exchange (the SSE). After about over 30 months of development, the SSE 50ETF option market has attracted enormous attention due to its fast expansion: 202,013 new trading accounts were opened in 2016, increased by 147.70% than that was in 2015; the average market value was 5.857 billion yuan, increased by 243%[3]. The average daily trading volume and year-end open interest of the 50ETF option increased about 200% in 2016, and the SSE 50ETF option market ranked 5th. among all ETF option markets worldwide[4]. Stylized facts of the 50ETF and international index option markets are shown in Table 1.

Table 1. Trading Volume Comparison between Top 5 ETF Index Options

Rank	ETF Index Option	Jan-Dec 2016	Jan-Dec 2015	%Change
1	SPDR S&P 500 ETF Options	671,661,453	655,942,274	2.40%
2	iShares Russell 2000 ETF Options	140,662,647	138,135,687	1.80%
3	Powershares QQQ ETF Options	111,873,109	120,174,871	-6.90%
4	iShares MSCI Emerging Markets ETF Options	87,941,483	78,473,551	12.10%
5	SSE 50ETF Option, Shanghai Stock Exchange	79,069,347	23,269,976	239.79%

Notes: Data of SSE50 options is from WIND database, other data is from FIA 2016 Volume Survey.

Such rapid growth in the liquidity and market size require a close examination of how to extract and interpret information from variables of 50ETF option contracts. Among which, one major topic is to predict the price patterns that could guide trading practices. And among all indicators that can potentially describe the market, the put-call ratio (PCR) that calculates a relative open-interest position of put options as per call options is considered to be one of the most intuitive and straightforward variables. It is straightforward to understand and widely believed to be informative since it is based upon market information and reflects investors' sentiment. Therefore, institutional investors who trade in Chinese index option market frequently adopt the PCR as a forward-looking indicator of the stock price. Literature seems to reach a consensus that a negative correlation can be found between the PCRs from stock index options and the stock market return (Pan and Poteshman, 2006, Chang, Hsieh and Lai, 2009, Billingsley and Chance, 2009).

In essence, this study emphasizes on the option market predictability. It helps us to learn whether and how investors who possess valuable private information might use derivatives to execute trades based on that information (Ge, Lin, Pearson, 2016). This is consistent with a recent booming in the studies focusing on extracting information

[1] The data is from Acworth (2016).

[2] The SSE 50ETF is an exchange-traded fund that tracks the SSE50 Index. And in this paper, we use the notations of "SSE 50ETF" and "50ETF" interchangeably.

[3] For more details, see the official release by the SSE: "Shanghai Stock Exchange Stock Option Market Development Report (2016)".

[4] The data is from Option Market Development Report (2015, 2016) and Liu (2016).

from the option market. They resort to various measurements such as price-based implied volatility (Xing, Zhang, and Zhao, 2010; Cremers and Weinbaum, 2010) or corporate events (Jin, Livnat, and Zhang, 2012; Lin and Lu, 2015; Chan, Ge, and Lin, 2015; Hayunga and Lung, 2014) in order to predict future stock returns.

However, research on the PCRs in the 50ETF option market is almost absent whilst lots of Chinese brokers publish reports implying the existence of some correlation. Most institutional reports are only descriptive rather than quantitative. Hence, this paper is motivated to fill this gap and to reveal a definite, if there is any, between the PCRs and 50ETF returns. It is after all possible that this relationship exhibits some complexity when its underlying (the Chinese A-share stock market) is highly volatile, and direct investments into the 50ETF option market confront heavy regulations. Therefore, we are also motivated to test higher moments influence and justify robustness if there is any. In addition, identifications of the index option market behavior in special periods such as the market crash show insights for policy makers and market participants.

The contribution of this paper is threefold: Firstly, the PCR implied by 50ETF option contracts is examined and tested for the effectiveness of forecast. In most of the testing periods, we find no evidence that the PCR can unconditionally predict any direction of the 50ETF price. This is different from international experience documented in past literature. Therefore, our results indicate a potential misuse of the 50ETF PCRs in trading practice. Secondly, we find a significant, negative and robust correlation between the PCR and next-day variance of 50ETF return. Thirdly, and most importantly, this study is among the very first few studies to comprehensively answer the question of what exactly the relationship between the PCRs and the underlying returns in Chinese 50ETF option market. This study therefore fills the blank of research on Chinese index option market. Our research points out the potential misuse of the popular PCR strategy by traders in Chinese option market and providing with a correct way of using it — to trade on variance.

The rest of the paper is structured as follows: Section 2 is a brief literature review and hypothesis development; Section 3 describes variables and the dataset; Section 4 outlines the methodology; Section 5 presents empirical results; Section 6 concludes the paper.

2. Literature review and hypothesis development

Past literature shows a consensus that a correlation does exist between the stock index option and stock market, and that information typically flows away from the option market into the underlying stock market due to the forward-looking feature of the option contracts. A study by Easley, O'Hara and Srinivas (1998) indicates that option volume by itself can be informative and shows the option market is a venue for information-based tradings. It also shows both positive and negative option volumes have predictive power for stock price movements (Blau and Wade, 2013; Chakravarty, et al., 2004). Therefore, a trading volume-based PCR is sensible to be chosen to be some forward-looking indicator. Blau, Nguyenb and Whitbyc (2014) compared two commonly used ratios, the PCR and OSR (Option-to-Stock Volume Ratio), and found that PCR contained more information on predictability about future stock returns at daily level while OSR performed well at weekly and monthly levels. Similarly, Bandopadhyaya and Jones (2011) and Weir (2015) found better explanatory power in the PCR than VIX for variations caused by non-economic factors and the PCR was more responsive than VIX. And Pan and Poteshman (2006) reveal the information content of the PCRs for options that were deep out-of-the-money. By using the same

model, Chang, Hsieh and Lai (2009) investigate the information content of options trading in the TAIEX option market. Their results showed that option volume (PCR), as a whole, carried no valid information on TAIEX spot index return. More generally, a study by Billingsley and Chance (2009) examines the predictive power of the PCRs in both the CBOE and the OEX, and argues the PCR can be used to predict the direction of the market. Many recent works in this field tend to support this argument (Connors and Alvarez, 2012; Houlihan and Creamer, 2014; Mehta and Patel, 2014; Blau and Brough, 2015; Wu, et al., 2016). But there does exist some disagreement (Zhou, 2003).

Institutional reports in this area are mostly descriptive and trade-oriented. Various PCR calculations are widely adopted in trading practices. Founder Securities Research (2015) analyzes the China 50ETF with autoregressive regression models on stock returns and finds that the residuals which cannot be explained by past returns might be attributed to non-economic factors such as emotional factors, of which PCR is among the most suitable ones. Large falls in the values of the PCRs signal the market touches the bottom. But since the history of 50ETF options is short and academic research is absent, so most published research stays on various qualitative analyses about the possible impact of 50ETF option on the stock market. The China SSE 50ETF Investment Guidelines (2004) compiled by Huaxia Fund Management Co., Ltd. summarizes its role as providing investors with ways to reduce market risk in bearish condition, and the "Review of the 50ETF on the First Anniversary" complied by Shanghai Stock Exchange in 2016 concludes three points: First, the 50ETF options enhanced the size and improved the liquidity of the underlying constituent securities. Second, the 50ETF options reduced the volatility of the underlying securities and improved the pricing efficiency. Third, the 50ETF options would not attract funds away from spot market but into it instead.

To sum up, in contrast to a large number of verified results in mature markets, academic research on Chinese index option market is mostly absent. By assuming a specific correlation does exist between the PCRs derived from 50ETF option contracts and the 50ETF returns, and according to empirical results by Pan and Poteshman (2006), Chang, Hsieh and Lai (2009), Billingsley and Chance (2009) and Connors and Alvarez (2012), this relationship is linear and negative. We develop three hypotheses:

H1: There is a negative correlation between the future return of the 50ETF and the current PCR of 50ETF options.

The "reversal effects" is stressed by Connors and Alvarez (2012) and Houlihan and Creamer (2014), which is supported by Pan and Poteshman (2006), Chang, Hsieh and Lai (2009). It means extremely low or high values of PCR contain more information than otherwise. To be specific, extreme PCRs represent an intensive sentiment that may influence the market. Therefore, the lower (or higher) the PCR is, the more likely the spot price is to reverse. Weir (2015) quantifies two important thresholds that significantly reflect investors' sentiments: less than 0.6 and more than 1.0. Additionally, PCR deviating from its MACD (moving average convergence/divergence) line of different rolling windows is also a useful trading indicator. Similar thresholds are calculated by Founder Securities Research Report (2015), which states that if the PCR falls to 0.3 from a higher position signals a market bottom. To examine this argument, we put it into the second hypothesis:

H2: The correlation between the next-day return of 50ETF and the current PCR is significantly stronger at extreme values.

Results from Houlihan and Creamer (2014) and Mehta and Patel (2014) suggest

that PCRs can predict directional moves of the underlying assets regardless of different market conditions. Thus, the correlation between option PCRs and the underlying returns is significant and robust. As for the Chinese market, the event of stock market crash in the summer of 2015 and the recovery afterward just stay in the middle of the two and half year long history of the 50ETF options. And this happens to provide us with a sample to examine the stability of the PCR predictability. And this robustness forms our third hypothesis:

H3: The correlation is stable under different market conditions

3. Dataset and variables

The full dataset of SSE 50ETF option contracts is drawn from the WIND database. It consists of all SSE 50ETF option contracts on a daily basis, including types of option (call/put), option characteristics (strike price and time to maturity), transaction prices, trading volume, and open interests. The time is from 9th. February 2015 to 31th. August 2017, and this covers all 626 valid trading days and 65,170 option contracts. Data of the price (or value) as per unit of SSE 50 ETF is also collected from the WIND database. The daily return of the 50ETF, R_t, is calculated in the form of log return as follows:

$$R_t = \ln(P_t) - \ln(P_{t-1}) \tag{1}$$

where P_t denotes the closing price of the 50ETF on date t. Among several approaches to calculate the PCR, this study adopts the open interest approach[5] by Fodor, Krieger and Doran (2011):

$$PCR_t = \frac{P_t}{C_t} \tag{2}$$

$$PCR_t' = \frac{P_t}{P_t + C_t} \tag{3}$$

where P_{it} and C_{it} are the numbers of open interests of all put and call options respectively (not ruling out any maturity or moneyness). The above two expressions are all widely used in past literature. In this study, we adopt the first expression and also tried the second one for robustness.

This study divides the full sample into subsamples based on the stock market crash in 2015. According to the Special Report of Tsinghua Financial Review, China's A-share stock market went through a quick booming and a sharp crash after reaching the peak on June 15th, 2015. The chronology of the crash is from 15th. June to 26th. August. We hence divide the subsamples as follows:

Phase 1 (before the crash): 9th. February, 2015 to 12th. June, 2015;
Phase 2 (after the beginning of the crash): 15th. June, 2015 to 31st. August, 2017;
Phase 3 (during the crash): 9th. February, 2015 to 26th. August, 2015;
Phase 4 (after the crash): 27th. August, 2015 to 31st. August, 2017.

For the purpose of reliability and robustness tests, Phase 1 and 3 are constructed to have an overlap before the market crash (Phase 2 and Phase 4 follow a similar feature). Then, by

[5] We also tried the trading volume approach but found results are highly noisy.

comparing regressions from Phase 1 and Phase 3 (or Phase 2 and Phase 4), the influence from the stock market crash can be detected.

All variables used in this research are listed in Table 2. Basic descriptive statistics of the dependent and independent variable as well as the control variables are listed in Table 3.

Table 2. Symbol and Explanation of Used Variables

Variables	Symbol	Explanations
Put-call Ratio	PCR	Open interests of put options divided by open interests of call options
Control variables	X_t	Variables that may contain explanatory power on dependent variables other than independent variables
Return	$R_{t+\tau}$	Return of 50ETF on the t+τ trading day
Control 1	Dummy×near maturity PCR	Interaction term between a dummy variable and the near-mature PCR: dummy variable=1 when there are options mature on next trading day near-mature PCR=PCR calculated by options matured on next trading day
Control 2	Volume	Daily closing 50ETF trading volume
Control 3	$R_{-5,-1}$	Past five-day 50ETF cumulative return
Control 4	$R^{+1}{}_{SCI}$	Next-day Shanghai Composite Index (SCI) return

Notes: Other mentioned but not adopted variables are given explanations in the context.

Table 3. Basic Descriptive Statistics of Adopted Variables

Panel A: Independent Variable

	PCR	PCR: Phase1	PCR: Phase2	PCR: Phase3	PCR: Phase4
Mean	0.7978	0.7766	0.8010	0.6637	0.8346
Standard Deviation	0.1977	0.0977	0.2086	0.1793	0.1864
Lowest	0.3324	0.6073	0.3324	0.3324	0.3849
Highest	1.3830	1.0654	1.3830	1.065	1.3830

Panel B: Dependent and Control Variables

	R_t	Control 1	Control 2	Control 3	Control 4
Mean	0.0003	0.0391	19.6922	0.0012	0.0001
Standard Deviation	0.0175	0.1821	0.9427	0.0386	0.0175
Lowest	-0.1052	0.0000	18.1703	-0.2452	-0.0887
Highest	0.0809	1.3576	22.9367	0.1666	0.0560

Notes: Basic descriptive statistics of independent and dependent variables are listed.

Table 3 suggests that the number of call-option open interests is higher than that of put option in general, and this is consistent with main stream literature. After the start of the market crash, volatility of PCR increases and the full-sample statistics is dominated by the after-crash part.

4. Methodology

4.1 OLS Regressions

We follow a simple OLS approach implemented by Pan and Poteshman (2006) as follows:

$$R_{t+\tau} = \alpha + \beta PCR_t + \gamma X_t + \varepsilon_{t+\tau},\ \tau = 1,2,\ldots,T \tag{4}$$

where $R_{t+\tau}$ denotes the daily logarithmic return of the 50ETF index on date $t+\tau$; X_t denotes control variable(s); PCR_t denotes the Put-Call-Ratio implied by the 50ETF options on date t, which is the information variable extracted from daily option under the framework of Pan and Poteshman (2006). The null hypothesis is that the 50ETF and its options are in separate equilibrium and that the information variable PCR has no predictive power at all, that is to say, for all $\tau = 1,2,\ldots,T$, $\beta = 0$. Second order moment of the return is analyzed with a similar model:

$$R^2_{t+\tau} = \alpha + \beta PCR_t + \gamma X_t + \varepsilon_{t+\tau},\ \tau = 1,2,\ldots,T \tag{5}$$

where $R^2_{t+\tau}$ denotes the squared logarithmic return of the 50ETF index on date t. Both daily and monthly returns are adopted.

4.2 Partition and Rolling Window

Pan and Poteshman (2006) showed that forecast power of PCR indicator is mainly reflected in its high-valued and low-valued cases. To study the predictive power of PCR in different value intervals (or with different deviation degree from the benchmark), and to facilitate statistical comparisons among different cases, we extend the four-partition regression model adopted by Low (2004) to a six-partition one. PCR values are separated into six partitions based on their deviation degree from the mean value (sample mean or rolling-window mean).

Specifically, deviation degree of PCR is measured by the number of standard deviations (denoted as sd) it deviated from the mean value. Six partitions are: slightly positive-deviated partition (denoted as P^{slight}) where mean<PCR<mean+1sd (PCR in this partition is denoted as PCR^{+}); ordinarily positive-deviated partition (denoted as $P^{ordinary}$) where mean+1sd<PCR<mean+2sd (PCR is denoted as PCR^{++}); extremely positive-deviated partition (denoted as $P^{extreme}$) where PCR>mean+2sd (PCR is denoted as PCR^{+++}); slightly negative-deviated partition (denoted as N^{slight}) where mean-1sd<PCR<mean (PCR is denoted as PCR^{-}); ordinarily negative-deviated partition (denoted as $N^{ordinary}$) where mean-2sd<PCR<mean-1sd (PCR is denoted as PCR^{--}) and extremely negative-deviated partition (denoted as $N^{extreme}$) where PCR<mean-2sd (PCR is denoted as PCR^{---}). All partitioned variables are defined as follows: taking PCR^{+++} as an example, PCR^{+++} defines the extreme values of PCRs if and only if they are larger than and outside two standard deviations of the rolling mean of the PCRs. Hence, the six-partition regressions are:

$$\begin{aligned}
(P^{extreme})R_{t+1} &= \alpha^{+++} + \beta^{+++}PCR_t^{+++} + \varepsilon_{t+1}^{+++} \\
(P^{ordinary})R_{t+1} &= \alpha^{++} + \beta^{++}PCR_t^{++} + \varepsilon_{t+1}^{++} \\
(P^{slight})R_{t+1} &= \alpha^{+} + \beta^{+}PCR_t^{+} + \varepsilon_{t+1}^{+} \\
(N^{slight})R_{t+1} &= \alpha^{-} + \beta^{-}PCR_t^{-} + \varepsilon_{t+1}^{-} \\
(N^{ordinary})R_{t+1} &= \alpha^{--} + \beta^{--}PCR_t^{--} + \varepsilon_{t+1}^{--} \\
(N^{extreme})R_{t+1} &= \alpha^{---} + \beta^{---}PCR_t^{---} + \varepsilon_{t+1}^{---}
\end{aligned} \tag{6}$$

To better detect PCR deviations from a relatively flexible and updated benchmark, rolling windows with lengths of 20 and 5 consecutive trading days are adopted, which represent 1 calendar month and 1 calendar week, separately. To avoid potential look-ahead bias. PCRs are divided into the mentioned six partitions based on the rolling means and the rolling standard deviations of the rolling window just prior to the date when PCR is calculated. For example, the partition that PCR on date t belongs to is decided by its deviation degree from the rolling mean and rolling variance of the window starts from day t-5 and ends on day t-1.

4.3 β-coefficient difference

To compare the predictive power of PCR in different partitions, we adopt the coefficient comparison model used by Low (2004). To test the statistical significance of differences between the slopes of the following two regressions:

$$R_{t+1}^{(1)} = \alpha_1 + \beta_1 PCR_t^{(1)} + \varepsilon_{t+1}^{(1)} \tag{7}$$

$$R_{t+1}^{(2)} = \alpha_2 + \beta_2 PCR_t^{(2)} + \varepsilon_{t+1}^{(2)} \tag{8}$$

We then rewrite the above models to check for the stability of the coefficients:

$$\begin{pmatrix} R_{t+1}^{(1)} \\ R_{t+1}^{(2)} \end{pmatrix} = \alpha_2 \begin{pmatrix} 1 \\ 1 \end{pmatrix} + \alpha_d \begin{pmatrix} 1 \\ 0 \end{pmatrix} + \beta_2 \begin{pmatrix} PCR_t^{(1)} \\ PCR_t^{(2)} \end{pmatrix} + \beta_d \begin{pmatrix} PCR_t^{(1)} \\ 0 \end{pmatrix} + \begin{pmatrix} \varepsilon_{t+1}^{(1)} \\ \varepsilon_{t+1}^{(2)} \end{pmatrix} \tag{9}$$

where α_d and β_d stand for $(\alpha_1-\alpha_2)$ and $(\beta_1-\beta_2)$, respectively. Specifically, to compare the difference of beta in different partitions, we pool the observations in the belonging partitions together and generate four regressors: a) a constant term which equals 1; b) a dummy variable which equals 1 if the observation belongs to the first partition and equals 0 if it belongs to the second partition; c) a PCR variable which without further calculation; d) a variable which equals PCR if the observation belongs to the first partition and equals to 0 if it belongs to the second partition. We regress the pooled next-day return as the dependent variable on these four variables and check the significance of α_d and β_d.

5. Empirical Results

5.1 PCR Predictability on 50ETF Return

We regress the next-day returns of the 50ETF fund on full-sample as well as six-partition subsamples of current PCRs. Six partitions are all based on the sample mean and standard deviation. Results are shown in Table 4.

Table 4. Results of Six-partition Regressions of 50ETF Return on 50ETF Options PCR

Regression	Constant	PCR	PCR^{---}	PCR^{--}	PCR^{-}	PCR^{+}	PCR^{++}	PCR^{+++}	D-W test	White test	R^2
$N^{extreme}$	0.1181 (0.47)		-0.3316 (-0.46)						2.32	6.29**	0.0176
$N^{ordinary}$	-0.0083 (-0.23)			0.0080 (0.11)					1.24	28.35***	0.0002
N^{slight}	0.0098 (0.66)				-0.0116 (-0.56)				1.73	16.18***	0.0015
P^{slight}	0.0032 (0.23)					-0.0032 (-0.21)			1.73	3.83	0.0002
$P^{ordinary}$	0.0212 (1.04)						-0.01840 (-0.97)		1.16	0.14	0.0133
$P^{extreme}$	0.0397 (0.84)							-0.0316 (-0.86)	1.26	3.03	0.0416

Notes: This table reports results of regressing the next-day 50ETF daily return on both the whole-sample of current-day PCR and the six partitions of the current-day PCR. Six partitions are divided according to the deviation degree from the sample mean: extremely negative-deviated (<mean-2 standard deviations (sd, the same below)), ordinarily negative-deviated (>mean-2sd, <mean-1sd), slightly negative-deviated (>mean-1sd, <mean), extremely positive-deviated (>mean+2sd), ordinarily positive-deviated (>mean+1sd, <mean+2sd), slightly positive-deviated (>mean, <mean+1sd). t-statistics are in parentheses. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level. White correlated t-statistics and GLS are also adopted and none of the coefficients are significant.

Coefficients of both full-sample PCRs and six-partition PCRs are all insignificant with R^2 below 0.05. For the four-partitioned sample according to negatively/positively deviated for less/more than 1 standard deviation, there is still no concrete evidence. Diagnostics such as Durbin-Watson (DW) and White tests for autocorrelation and heteroscedasticity all tell potential problems of misspecification. The GLS and heteroscedasticity-consistent t-tests are then adopted to address the issue. But results stay the same[6]. Such a result as the PCR does not provide any forecast power on the next-day return is inconsistent to Pan and Poteshman (2006) that proves otherwise in the US market, but consistent to the findings in TAIEX options by Chang et al. (2009).

It is possible that PCRs fluctuate greatly throughout the whole time period but cluster in some shorter intervals. Therefore, the mean and standard deviation of the full sample may be inadequate to diagnose short-term fluctuations. So in the next step, we take 5- and 20-day rolling windows to identify short-run dynamics. The regression results are shown in Table 5.

[6] The results of GLS and heteroscedasticity-consistent t-values are omitted but available upon request.

Table 5 Results of Six-partition Regressions of 50ETF Return on 50ETF Option PCR —Rolling Windows of 20, 5 Trading days

Six-partitions	20-day rolling window				5-day rolling window			
	OLS-Slope (β)	GLS		R^2	OLS-Slope (β)	GLS		R^2
	t-statistics	White-corrected t-statistics	t-statistics		t-statistics	White-corrected t-statistics	t-statistics	
PCR^{+++}	0.0090 (1.05)	0.8	1.06	0.0140	0.0171** (2.09)	1.57	3.07***	0.0426
PCR^{++}	-0.0003 (-0.05)	-0.04	-0.06	0.0000	0.0092 (1.41)	1.44	1.42	0.0195
PCR^{+}	-0.0008 (-0.10)	-0.11	-0.10	0.0000	-0.0268*** (-3.66)	-2.49**	-3.69***	0.1035
PCR^{-}	-0.0138 (-1.63)	-1.33	-1.65*	0.0203	-0.0091 (-1.18)	-0.91	-1.19	0.0112
PCR^{--}	0.0085 (0.86)	0.53	0.86	0.0057	-0.0023 (-0.22)	-0.15	-0.22	0.0004
PCR^{---}	0.0504** (2.19)	1.23	2.24**	0.0944	0.0580*** (4.01)	2.59**	4.07***	0.1956

Notes: This table reports results of regressing returns of 50ETF on six partitions of 50ETF option PCRs based on their deviation degree from the rolling means. All partitions show autocorrelation in D-W tests while all partitions except PCR^{+} in 20-day and PCR++ in 5-day rolling windows show heteroscedasticity in White tests. OLS t-statistics are in parentheses. To address autocorrelation and heteroscedasticity, GLS t-statistics and White corrected t-statistics are adopted. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level.

The results of six-partition regressions, without control variables, show that we are unable to find significant predictive power from most of the partitions. However, there are still some significant results. First, some slopes of extremely high and low[7] PCRs (denoted as PCR^{+++}) are positive and the shorter the length of the rolling window, the more significant the slope coefficient is, which means extreme PCR values are predictive. Second, extremely low PCRs are more predictive than extremely high PCRs, according to the β-difference test. However, such pattern in extreme cases does not hold in other partitions, where the results are unstable and hard to summarize. Almost all partitions show autocorrelation in D-W tests and heteroskedasticity in White tests. To address autocorrelation and heteroskedasticity, GLS t-statistics and White corrected t-statistics are adopted. The results are robust. The results mean that extremely high or low PCR provides significant positive predictive power[8] to the next-day return of 50ETF but the degree of deviation should be more than 2 standard deviations.

Besides regressions of the next-day return, +τ-day returns are also examined in order to investigate longer periods of information content. Considering that the regression results of rolling windows no shorter than 20 days are not significant, we only extend the predictability horizon to 20 days (τ=1,2,...,20) and test both full-sample PCRs and the extremely high and low PCRs in 5-day rolling windows, finding that full-sample PCRs are insignificant in any τ while extremely low PCRs

[7] The notation ”extremely low/high PCR” represents PCRs that are negatively/positively deviated from the rolling means for more than 2 rolling standard deviations, for the purpose of simplifying the presentation, the same below.

[8] Positive predictive power (predictability) means PCRs and 50ETF returns move in the same direction while negative predictive power (predictability) means PCRs and 50ETF returns move in contrary direction.

show positive predictive power on +1, +2, +14 and +20 days, and extremely high PCRs show positive predictive power on +1, +5 and +10 days. The results are reported in Table 6.

Table 6. Test of PCR Predictability Horizon on 50ETF Return

+τ Days ahead	All PCR		Extremely low PCR (PCR^{---})		Extremely high PCR(PCR^{+++})	
	Slope coefficient	t-Statistic/ GLS z-statistic	Slope coefficient	t-Statistic/ GLS z-statistic	Slope coefficient	t-Statistic/ GLS z-statistic
1	0.0034	0.97/0.97	0.0580***	4.01/4.07	0.0171**	2.09/2.11
2	0.0031	0.86/0.87	0.0532***	3.70/3.76	0.0003	0.04/0.04
3	0.0011	0.30/0.30	-0.0140	-0.80/-0.81	0.0036	0.45/0.45
4	0.0016	0.46/0.46	-0.0029	-0.17/-0.17	0.0067	1.06/1.07
5	0.0015	0.43/0.43	-0.0198	-1.46/-1.49	0.0122*	1.69/1.71
6	0.0039	1.09/1.09	-0.0173	-1.24/-1.26	0.0011	0.19/0.19
7	0.0035	0.96/0.96	-0.0015	-0.12/-0.12	-0.0105	-1.65/-1.67*
8	0.0025	0.70/0.70	0.0115	0.90/0.92	0.0043	0.74/0.75
9	0.0025	0.69/0.69	-0.0058	-0.44/-0.44	0.0022	0.26/0.26
10	0.0033	0.91/0.92	-0.0023	-0.19/-0.20	0.0206**	2.23/2.26
11	0.0032	0.89/0.89	0.0078	0.54/0.55	0.0002	0.03/0.03
12	0.0021	0.58/0.59	-0.0110	-0.73/-0.74	-0.0026	-0.40/-0.40
13	0.0030	0.84/0.84	0.0107	0.74/0.75	0.0040	0.55/0.56
14	0.0042	1.17/1.18	0.0251*	1.67/1.69	0.0132	1.56/1.58
15	0.0038	1.06/1.06	0.0109	0.74/0.76	0.0016	0.20/0.20
16	0.0033	0.91/0.91	-0.0051	-0.42/-0.42	-0.0060	-0.89/-0.90
17	0.0044	1.23/1.23	0.0171	1.37/1.40	0.0060	0.77/0.78
18	0.0031	0.86/0.86	0.0088	0.72/0.73	0.0041	0.53/0.54
19	0.0037	1.03/1.04	0.0151	1.46/1.48	0.0024	0.30/0.30
20	0.0032	0.87/0.87	0.0163*	1.85/1.88	-0.0087	-1.12/-1.13

Notes: This table reports results of regressing returns of 50ETF on all 50ETF option PCRs and the subsample of PCRs that are negatively and positively deviated from 5-day rolling means for more than 2 rolling deviations (presented as extremely low and extremely high) on an extended horizon from +1 to +20 days. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level. If the asterisk is on the t-statistic or z-statistic, it means that the significance exists only on the corresponding regression.

Thus the predictive power of PCRs only contains in extreme cases and the extremely low PCRs are more indicative. Also such predictive power is concentrated on the next-day return but not robust for longer period.

To further investigate the predictive power of extreme PCRs in a 5-day rolling window and make sure the univariate regression results are not dominated by other factors other than the PCR, control variables are added. Similar to Chang et al. (2009), we adopt an interaction term between a dummy variable and the near-maturity PCR as the maturity control. The dummy variable takes the value 1 if there are one or more options about to mature on the next trading day, otherwise it takes the value 0. The near-maturity PCR is calculated by options that will expire in the next trading day. For liquidity control, we add in the daily closing 50ETF trading volume. For reversal control, we add in the past five-day 50ETF cumulative return $R_{-5,-1}$. And we also add in the next-day Shanghai Composite Index return to control the correlation between

the stock market and the option market. Table 7 shows the results of regressions of extremely low PCRs under a 5-day rolling window with the above control variables.

Table 7. Predictability from Extremely low PCR in 5-day Rolling Window Regressions with Control Variables

PCR	Dummy×near maturity PCR	Volume	$R_{-5,-1}$	R^{+1}_{SCI}	R^2
0.0591***	-0.0025				0.20
(3.97)	(-0.38)				
0.0650***	-.00356	0.0000			0.21
(4.12)	(-0.53)	(1.11)			
0.0561***	-0.0039		0.05719		0.21
(3.06)	(-0.55)		(0.71)		
0.0637***	-0.0071	0.0000	0.0964		0.23
(3.37)	(-0.95)	(1.43)	(1.14)		
0.0630***		0.0000			0.21
(4.14)		(1.05)			
0.0551***			0.0467		0.20
(3.04)			(0.60)		
0.0605***		0.0000	0.0714		0.22
(3.25)		(1.21)	(0.89)		
0.0559***				0.08641	0.20
(3.78)				(0.76)	
0.0571***	-0.0029			0.0898	0.21
(3.77)	(-0.43)			(0.78)	
0.0629***	-0.0037	0.0000		0.0651	0.22
(3.85)	(-0.55)	(0.96)		(0.55)	
0.0550***	-0.0043		0.0540	0.0836	0.21
(2.98)	(-0.60)		(0.66)	(0.69)	
0.0626***	-0.007	0.0000	0.0920	0.0511	0.24
(3.25)	(-0.95)	(1.31)	(1.07)	(0.42)	
	-0.0010	0.0000	0.1779**	0.1065	0.10
	(-0.37)	(0.32)	(2.02)	(0.81)	

Notes: This table reports results of regressing next-day returns of 50ETF on extremely low 50ETF option PCRs in 5-day rolling windows with four control variables: expiration dummy interacting with PCR, the daily closing trading volume of 50ETF, the five-day accumulated 50ETF return, and the next-day Shanghai Composite Index (SCI) return. t-statistics are in parentheses. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level.

From the results in Table 6, we find that the extremely low PCRs in the 5-day rolling window still has strong predictive power in all of the regressions and the R^2 are all above 20%. Thus, these controls have no impact on PCR's next-day return predictability since none of them are significant. The case of extremely high PCRs shows similar results and both cases are robust under GLS regression[9].

5.2 Predictability on Squared 50ETF Return

Literature tends to link the PCR to a reflection of market sentiment. Therefore, there is a possibility that the "sentiment" would not directly affect the 50ETF return but its variance instead. This section extends our investigation to examining the second-order moment of return (R_t^2) to see potential nonlinearity. Regressions on the full-sample as well as six-partition subsamples are repeated but with a different dependent variable. Results are reported in Table 8.

[9] The cases of extremely high PCRs and GLS results are omitted but available upon request.

Table 8. Results of All Regressions of 50ETF Squared Return on 50ETF Option PCR—Rolling Windows of 20, 5 trading days

Six-partitions	20-day rolling window				5-day rolling window			
	OLS-Slope (β)		GLS		OLS-Slope (β)		GLS	
	t-statistics	White-corrected t-statistics	t-statistics	R^2	t-statistics	White-corrected t-statistics	t-statistics	R^2
PCR^{+++}	-0.0012** (-2.11)	-1.46	-2.14**	0.0548	-0.0015*** (-3.14)	-2.23**	-3.17***	0.0912
PCR^{++}	-0.0006*** (-3.12)	-3.28***	-3.14***	0.0650	-0.0004** (-2.18)	-1.81*	-2.2**	0.0454
PCR^{+}	-0.00056* (-1.95)	-2.20**	-1.97**	0.0392	-0.0015*** (-3.98)	-2.09**	-4.01***	0.1202
PCR^{-}	-0.0013*** (-3.70)	-2.81***	-3.73***	0.0958	-0.0012*** (-4.27)	-3.29***	-4.30***	0.1289
PCR^{--}	-0.0027*** (-6.25)	-3.63***	-6.30***	0.2336	-0.0021*** (-4.26)	-2.74***	-4.30***	0.1415
PCR^{---}	-0.0070*** (-4.71)	-2.80***	-4.82***	0.3257	-0.0045*** (-4-18)	-2.23**	-4.25***	0.1975

Notes: This table reports results of regressing squared return of 50ETF on both the whole-sample and six-partition All partitions show autocorrelation in D-W tests while all partitions except PCR^{+} and PCR^{++} in 20-day rolling windows show heteroskedasticity in White tests. OLS t-statistics are in parentheses. To address autocorrelation and heteroskedasticity, GLS t-statistics and White corrected t-statistics are adopted. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level.

Regressions in Table 8 shows strong and robust significance of the PCR as a forecast of the future short-term index variance. All coefficients of the PCRs are negative, indicating a fact that the lower the PCR, the higher the R_t^2 on the next trading day. We also find that for both 5- and 20-day rolling windows, higher deviation from the rolling mean implies higher R^2 and higher coefficients in terms of absolute value. By conducting β-tests, low partitions show higher significance (and higher absolute value of coefficients) than high partitions of the same deviation. Evidence shows the predictive power is asymmetric and low PCRs contains more information, especially for the extreme cases. Results from the model using 20-day rolling window show better performance (higher R^2, R^2 of PCR^{---} in 20-day rolling window reaches 32.57%, the highest among all models) than the 5-day rolling window scenario.

As the R_t^2 can be interpreted as a measure of the realized variance, we then find that the more optimistic the market is (PCR decreases), the higher the variance will be. Such optimistic sentiment may translate into future stock market risk, which might help explain the fact that the lower the PCR is, the more predictive power it has. When control variables are added, the above results remain stable and robust[10]. Predictive power on (t+τ)-day ahead returns is also. Predictability horizons are 1 to 20 days (τ=1, 2, ..., 20) and the results are reported in Table 9:

[10] Omitted but available upon request.

Table 9. Test of PCR Predictability Horizon on Squared 50ETF Return

+τ Days ahead	All PCR		Extremely low PCR (PCR^{---})		Extremely high PCR(PCR^{+++})	
	Slope coefficient	t-Statistic/ GLS z-statistic	Slope coefficient	t-Statistic/ GLS z-statistic	Slope coefficient	t-Statistic/ GLS z-statistic
1	-0.0015***	-8.52/-8.54	-0.0070***	-4.71/-4.82	-0.0012**	-2.11/-2.14
2	-0.0015***	-8.3/-8.31	-0.0062***	-5.22/-5.33	-0.0015**	-2.52/-2.55
3	-0.0014***	-7.75/-7.76	-0.0032***	-3.65/-3.73	-0.0015**	-2.51/-2.54
4	-0.0014***	-7.28/-7.29	-0.0031***	-3.44/-3.52	-0.0004	-1.03/-1.04
5	-0.0013***	-6.93/-6.94	-0.0017***	-3.40/-3.47	-0.0004	-1.04/-1.05
6	-0.0012***	-6.52/-6.53	-0.0010*	-1.89/-1.93	-0.0006	-1.55/-1.57
7	-0.0012***	-6.2/-6.21	-0.0024***	-3.39/-3.46	-0.0005	-1.28/-1.30
8	-0.0012***	-6.06/-6.07	-0.0040***	-5.07/-5.17	-0.0005	-0.89/-0.90
9	-0.0011***	-5.62/-5.63	-0.0026***	-3.43/-3.50	-0.0005	-0.80/-0.81
10	-0.0011***	-5.63/-5.64	-0.0020**	-2.61/-2.67	-0.0005	-0.74/-0.75
11	-0.0011***	-5.85/-5.86	-0.0016**	-2.31/-2.36	-0.0005	-1.01/-1.02
12	-0.0011***	-5.73/-5.74	-0.0002	-0.52/-0.53	-0.0005	-0.89/-0.91
13	-0.0010***	-5.40/-5.41	0.0000	0.08/0.08	-0.0004	-0.75/-0.76
14	-0.0010***	-5.32/-5.33	-0.0004	-1.19/-1.22	0.0000	-0.04/-0.04
15	-0.0010***	-5.18/-5.19	-0.0003	-1.17/-1.20	-0.0002	-0.51/-0.52
16	-0.0009***	-4.92/-4.93	0.0001	0.25/0.26	-0.0005	-0.94/-0.96
17	-0.0009***	-4.86/-4.87	0.0001	0.34/0.34	-0.0004	-0.77/-0.78
18	-0.0009***	-4.82/-4.83	0.0001	0.22/0.23	-0.0007	-1.28/-1.30
19	-0.0009***	-4.91/-4.91	0.0000	-0.01/-0.01	-0.0007	-1.61/-1.63
20	-0.0010***	-4.95/-4.96	-0.0023**	-2.13/-2.17	-0.0015	-1.89/-1.91

Notes: This table reports results of regressing returns of 50ETF on all 50ETF option PCRs and the subsample of PCRs that are negatively and positively deviated from 5-day rolling means for more than 2 rolling deviations (presented as extremely low and extremely high) on an extended horizon from +1 to +20 days. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level. If the asterisk is on the t-statistic or z-statistic, it means that the significance exists only on the corresponding regression.

The significant predictive power of all PCRs last for at least 20 days but decrease gradually. Predictive power of extremely low PCRs lasts for 11 days while that of extremely high PCRs lasts for only 3 days. All significant coefficients are negative, similar to the case of one-day ahead prediction.

These results inspire us to investigate the predictive power not only on daily level but also on monthly level for potentially stable outcome. Using the same six-partition framework under the 20-day rolling window. Monthly returns of the 50ETF and monthly PCRs of 50ETF options are introduced as new dependent and independent variables. The coefficients of the six partitions (from PCR^{+++} to PCR^{---}) are: -0.0016 (insignificant), -0.0163 (99% significance), 0.0218 (99% significance), -0.0249 (99% significance), -0.0157 (99% significance) and -0.0693 (99% significance). The R^2 (from PCR^{+++} to PCR^{---}) are: 0.15%, 12.81%,12.11%, 15.58%, 9.67% and 45.02%. Hence, the results are consistent to the daily cases where significant predictive power only applicable in the extremely low PCRs. And, for the lowest partition (PCR^{---}), monthly PCR can explain more than 45% of the variance of the return.

Compare with the results from previous sections, PCRs of the 50ETF options is

better used to predict the variance of the 50ETF return, rather than the 50ETF return. And this is consistent with the treatment of PCRs as market sentiment by academia. In addition, we follow the study by Gang et al. (2014) that discusses the relationship between stock return and the VIX and regress the second order of Chinese volatility index (iVX^2) on monthly R_t^2 of 50ETF[11]. Empirical results show a very significant coefficient (the t-value is 17.89). This implies the iVX is highly correlated with PCR but in a nonlinear way.

5.3 Predictability Before and After the Stock Market Crash

Chinese stock market has gone through a severe crash in the summer of 2015. The start of the crash coincides with the beginning of a sharp falling after months of consecutive run-ups. 15th. June, 2015 is the date when the market reached the peak. 26th. August is the end of the third stage defined in the Special Report of Tsinghua Financial Review. Our study separates the whole sample into two sets of divisions: Phase 1 and Phase 2, Phase 3 and Phase 4. Such division enables us to compare predictability of the PCR under different market conditions. Both regressions of 50ETF return and R_t^2 are summarized in Table 10.

Table 10. Predictability in Different Phases of the Market Crash

	PCR	All PCR			Extremely low PCR			Extremely high PCR		
	Phases	Slope (β)	GLS z-statistic	R^2	Slope (β)	GLS z-statistic	R^2	Slope (β)	GLS z-statistic	R^2
R_{t+1}	Phase1	-0.0193 (-0.86)	-0.87	0.01	-0.0036 (-0.16)	-0.21	0.00	-0.1227 (-1.54)	-1.70*	0.21
	Phase2	0.0045 (1.28)	1.29	0.00	0.0626*** (3.87)	3.94***	0.22	0.0207** (2.58)	2.61***	0.0712
	Phase3	0.0147 (1.02)	1.03	0.01	0.1113*** (3.09)	3.27***	0.36	0.0738* (1.70)	1.80*	0.1522
	Phase4	-0.0002 (-0.06)	-0.06	0.00	0.0266* (2.00)	2.04**	0.08	0.0023 (0.35)	0.36	0.0016
R^2_{t+1}	Phase1	-0.0012* (-1.66)	-1.68*	0.03	-0.0003 (-0.36)	-0.38	0.01	-	-	-
	Phase2	-0.0016*** (-8.11)	-8.13***	0.11	-0.0095*** (-3.75)	-3.90***	0.37	-0.0013** (-2.06)	-2.08**	0.0555
	Phase3	-0.0037*** (-4.68)	-4.72***	0.14	-0.0079*** (-4-08)	-4.23***	0.38	-	-	-
	Phase4	-0.0005*** (-5.00)	-5.02***	0.05	-0.0009** (-2.43)	-2.57***	0.26	-0.0004* (-1.87)	-1.89*	0.0494

Notes: This table reports results of the regressions of whole PCR and extremely low and high PCRs (Return: in 5-day rolling windows, squared return: in 20-day rolling windows) in the full interval and 4 phases: before/after the beginning of the market crash, before/after the ending of the market crash. Pase1: 2015.2.9~2015.6.12, Phase 2: 2015.6.15~2017.8.31, Phase3: 2015.2.9~2015.8.26, and Phase4: 2015.8.27~2017.8.31. t-statistics are in parentheses. One, two and three asterisks (*) respectively indicate the t-values are significant at the 0.1, 0.05 and 0.01 level. Two cases in extremely high PCRs are omitted due to lack of observations.

As shown in Table 10, the predictability of extremely low PCR on 50ETF return is not robust while the predictability on squared return is robust. The most important result comes from comparisons between Phase 1 and Phase 3 (as well as phase 2 and phase 4), which shows that even only few more observations from the market crash

[11] iVX is the combination of implied volatility of different options that aims at predicting the next 30-day volatility of 50ETF. iVX^2 is adopted as it corresponds to the square of return, both of which are in a form of second order moments.

period are added, the insignificant result of 50ETF return is turned into a highly significant one in regressions of extreme high or low PCRs. The result of the whole sample is dominated by the period of the stock market crash, once the period of the market crash is included in the sample, the results are likely to be significant and with high coefficients. However, PCR's predictive power on squared return is robust across all phases.

It is notable that August 26$^{th.}$ 2015 is merely the end of the sharpest falling period, but not the true end of the market crash (there is no such definition). In addition, there are two adjustments on open position limitation instituted by China Securities Regulatory Commission (the CSRC, China's securities and derivatives regulatory authority)[12]. To better analyze the results after the stock market crash, we repeat the regressions on the three phases of limitations and the coefficients of PCR^{---} under loose limitation (2015.2.9~2015.9.8), strict limitation (2015.9.9~2016.8.8) and medium limitation (2016.8.9~2017.8.31) are 0.1113 (99% significance, t-value=3.09), 0.0355 (insignificant, t-value=1.56) and 0.01 (insignificant, t-value=0.63). By contrast, results of squared return are robust during all different limitations.

Thus, we can deduce that the major contributor of PCR's positive predictive power on next-day 50ETF return concentrates in the sharp falling period during the stock market crash. After the market crash, such obvious positive predictability of extremely low PCRs vanishes. However, PCR's positive predictive power on next-day 50ETF squared return is robust under different market conditions.

Additionally, results using another form of PCR (PCR') show no material differences in all tests above but only minor numerical differences, which can also be viewed as a form of robustness check. The results are omitted here but available upon request.

6. Conclusion

This paper investigates the predictive power of the put-call-ratio (PCR) implied by Chinese SSE 50ETF option contracts on the return of the SSE 50ETF. Using partitioned and conditional OLS regressions, relationship between the PCR and the 50ETF are estimated and tested on different time horizons. Empirical results indicate that PCR predicts the variance of the 50ETF return, rather than 50ETF return itself.

First, in most of the testing periods, we find no evidence that the PCR can unconditionally indicate any direction of the 50ETF price. This is different from documented literature. Therefore, our results indicate the possible misuse of the 50ETF-PCR towards predicting the 50ETF price. Although during the stock market crash a significant and positive correlation emerged very shortly, it is only applicable between the next-day 50ETF returns and extremely low PCRs of 50ETF options. Such a positive correlation only holds during the sharp falling period of the market crash but far from a general rule. And by detailed work on deviation partitions and time period segmentations, we find that the PCR fails to provide robust predictability on future

[12] During the severe market fluctuations, the CSRC authorized the SSE to temporarily limit the opening position of the 50ETF option from maximum 50,000 contracts per day to no more than 5,000 contracts per day (effective on September 8th, 2015 until August 8th, 2016). On August 8th, 2016, the SSE once again loosed the limit to no more than 10,000 contracts, which is effective till now.

50ETF returns.

Second, there is a robust, significant and negative correlation between the PCR and one-step-ahead return variance of the 50ETF index (daily and monthly). This significant forecasting power is especially stronger in low PCR values and during the market crash. And it is stable and robust under other market conditions.

To conclude, this study is among the very first research on the relationship between the PCRs and the returns of 50ETF. Our results show, unlike literature on this topic targeting developed option markets, the PCR predicts the variance of 50ETF return rather than the 50ETF return itself. The optimistic sentiment of the market indicates higher variance. We fill in the blank by issue a research on the 50ETF PCR. This research points out the wide misuse of the PCRs in China while providing a correct way of using it - trade on variance.

References

Acworth, W. (2016). 2015 Annual Survey: Global Derivatives Volume—Asia Takes the Lead. Market Voice, 3.

Bandopadhyaya, A., & Jones, A. L. (2011). Measures of Investor Sentiment: A Comparative Analysis Put-Call Ratio Vs. Volatility Index. International Journal of Economics & Business Research, 6(8), 27-34.

Billingsley, R. S., & Chance, D. M. (2009). Put—call ratios and market timing effectiveness. Journal of Portfolio Management, 15(1), 25-28.

Blau, B. M, Nguyen, N., & Whitby, R. J. (2014). The information content of option ratios. Journal of Banking & Finance, 43(6), 179-187.

Blau, B. M., & Brough, T. J. (2015). Are put-call ratios a substitute for short sales? Review of Derivatives Research, 18(1), 51-73.

Blau, B. M., & Wade, C. (2013). Comparing the information in short sales and put options. Review of Quantitative Finance and Accounting, 41(3), 567-583.

Cao, C., Chen, Z., Griffin, J. (2005). Informational content of option volume prior to takeovers. Journal of Business 78, 1073–1109.

Chakravarty, S., Gulen, H., & Mayhew, S. (2004). Informed Trading in Stock and Option Markets. The Journal of Finance, 59(3), 1235–1258.

Chan, K., Ge, L., Lin, T., (2015). Informational content of options trading on acquirer announcement return. Journal of Financial and Quantitative Analysis 50, 1057–1082.

Chang, C. C., Hsieh, P. F., & Lai, H. N. (2009). Do informed option investors predict stock returns? Evidence from the Taiwan stock exchange. Journal of Banking & Finance, 33(4), 757-764.

China SSE 50ETF investment guidelines. (2004). China Asset Management Co. China Economic Publishing House.

Connors, L. A, & Alvarez, C. (2012). How Markets Really Work: A Quantitative Guide to Stock Market Behavior (2nd ed.).

Cremers, M., Weinbaum, D. (2010). Deviations from put–call parity and stock return predictability. Journal of Financial and Quantitative Analysis 45, 335–367.

Development Path of ETF Options and Index Options. (2016). Derivative Product Innovation Department of Shenzhen Stock Exchange, 6, 57-61.

Easley, D., O'Hara, M., & Srinivas, P. S. (1998). Option Volume and Stock Prices: Evidence on Where Informed Traders Trade. The Journal of Finance, 53(2), 431-465.

FIA 2016 Annual Volume Survey: Global Futures and Options Volume Reaches

Record Level. (2017). Retrieved from https://fia.org/categories/exchange-volume.
Fodor, A., Krieger, K., & Doran, J. S. (2011). Do option open-interest changes foreshadow future equity returns? Financial Markets & Portfolio Management, 25(3), 265-280.
Gang, J., & Li, X. (2014). Risk perception and equity returns: evidence from the spx and vix. Bulletin of Economic Research, 66(1), 20–44.
Ge, L., Lin, T., Pearson, N. (2016). Why does the option to stock volume ratio predict stock returns? Journal of Financial Economics, 120, 601-622.
Hayunga, D., Lung, P. (2014). Trading in the options market around financial analysts' consensus revisions. Journal of Financial and Quantitative Analysis 49, 725–747.
Houlihan P., & Creamer G. G. (2014). Leveraging a Call-Put Ratio as a Trading Signal.
Social Science Electronic Publishing, 21(1), 1-23.
Jin, W., Livnat, J., Zhang, Y. (2012). Option prices leading equity prices: do option traders have an information advantage? Journal of Accounting Research 50, 401–432.
Liu, D. (2016). A review of the 50ETF Options Trial For one Year. China Finance, 4, 58-60.
Lin, T., Lu, X. (2015). Why do options prices predict stock returns? Evidence from analyst tipping. Journal of Banking and Finance 52, 17–28.
Low, C. (2004). The Fear and Exuberance from Implied Volatility of S&P 100 Index Options. Journal of Business, 77(3), 527-546.
Mehta, S., & Patel, N. (2014). Impact of Option Interest and Put-Call Ratio Information in Derivatives Market: an Empirical Study of Option and Future Market. Indian Securities Market: A Review.
Option Market Development Report. (2015). Derivatives Division of Shanghai Stock Exchange.
Pan, J., & Poteshman, A. M. (2006). The Information in Option Volume for Future Stock Prices. Review of Financial Studies, 19(3), 871-908.
Stock Option Market Development Report. (2016). Derivatives Division of Shanghai Stock Exchange.
Weir, D. (2015). Timing the Market: How to Profit in the Stock Market Using the Yield Curve. Technical Analysis and Cultural Indicators. Biochemistry, 47(5), 1369-80.
Wu, W. H., Tsai, H. H., & Wu, M. E. (2016). The Delayed Effect of Stealth Trading of Major Traders on Taiwan Stock Index Options. International Conference on Business and Information.
Xing, Y., Zhang, X., Zhao, R. (2010). What does the individual option volatility smirk tell us about future equity returns? Journal of Financial and Quantitative Analysis 45, 641–662.
Zhou, J. Y. (2003). Can Put/Call Ratios Help Predict the Stock Market? An Empirical Examination. Aomori Public College Journal of Management & Economics, 9, 3-19.