Option returns around earning announcement in London

Mr. Thanawat Thangchadakorn

จุฬาลงกรณ์มหาวิทยาลัย
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By	Mr. Thanawat Thangchadakorn
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Thesis Advisor	Tanawit Sae-Sue, Ph.D.

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INDEPENDENT STUDY COMMITTEE

.... Chairman

()

.... Advisor

(Tanawit Sae-Sue, Ph.D.)

.... Examiner

(Associate Professor Kanis Saengchote, Ph.D.)

.... Examiner

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While prior studies find that returns on straddles constructing before earning announcements are positive in U.S. equity option market, we further investigate and find that returns on straddle constructing before earning announcement are positive in London Stock Exchange either. The logic behind this positive return while return on straddles are generally negative is option traders underestimate volatility of upcoming earning announcement period due to recency bias.

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Introduction

Almost all investors who enter the stock market do really require the return from investment. There are also various methods and strategies which could generate the return from investment. Financial products are also used to initiate investment strategy. The frequently ask question is which strategy could give them profit with less risk or perhaps no risk at all. The straddle option is one of the popular option strategies that could generate return whether the stock price goes in either direction. Despite straddle option's generated profit, the stock price needs to be volatile enough to compensate the option premium that we paid when primarily constructed the strategy.(Coval & Shumway, 2001) found that at-the-money straddle portfolio generally provided average losses of nearly three percent a week. However, some special event, such as earning announcement, could affect stock return to become more volatile and could potentially generate abnormal return from investing option. According to (Frazzini & Lamont, 2007), earning announcement drove the stock price volatility up and triggered retail investors attention especially when such announcement was a surprise. It is interesting to see whether option investors can predict volatility of such market event and adjust their valuation of option price efficiently accordingly.

Numerous studies found that investors could possibly predict stock option return. (Jin et al., 2012) found that option traders have persistent information advantage and higher capability to anticipate short-term return prior to earning announcement. (Alldredge et al., 2011) also agreed that pre-announcement option activity contained private information despite mostly influenced by speculation. In the opposite, (Choy & Wei, 2012) showed that option market could be less efficient than expected due to the incoming of unsophisticated investors. Furthermore, "volatility misestimation is the most obvious source of option mispricing" was argued by (Goyal & Saretto, 2009). Although mainstream studies of measurement and predicting volatility is a mean-reversion, the deviation of implied volatility from historical volatility could temporarily occur and follow with extreme pattern in stock return meaning that investors overreact to ongoing events by increasing their prediction of future volatility after large negative stock return and decreasing their prediction of future volatility after positive stock return. This behavior could be described by (Tversky & Kahneman, 1973) that recent activity could be

mentally recognized due to availability bias. (Kariofyllas et al., 2017) also confirmed availability of cognitive biases trends that investors fail to predict while processing financial information over the long-term period. The consistency of prior performance could potentially comprise representative biases and then over-reaction and adverse to under-reaction due to conservatism in case of lacking short-term existence of persistent.

Desired uncovering question, (Chung & Louis, 2017) followed (Goyal & Saretto, 2009) and found that we could generate return by constructing straddle option before earning announcement date. However, we could lose money in case we constructed straddle option after announcing. Moreover, they found that return could be greater if we implement hedging strategy by both long straddle option before earning announcement and short straddle option after recent announcing. The reason behind was the investors underestimated the future volatility of upcoming earning announcement while they overestimated the future volatility after recent announcing, inducing the implied volatility to be unadjusted and overweighted before and after announcement, respectively. This phenomenon was a form of recency bias. (Chung & Louis, 2017) also examined that earning announcement effect was distinct from volatility spread effect regard to (Goyal & Saretto, 2009). The two effects were both incremental to each other and complementary.

Based on (Chung & Louis, 2017) and (Goyal & Saretto, 2009) who studied US stock market, we adopt similar research methodology to study in London Stock Exchange to examine whether we could generate return from constructing straddle option before earning announcement. London Stock Exchange, in the past recent years, encountered many interesting situations including Brexit and debt crisis in the nearby European countries. Equivalent to big political uncertainty in many countries, Brexit issue concerns all European Union area including the United Kingdom. It could frighten the London Stock Market and might spur volatility or influence option trading in significant ways. Apart from earning announcement event that regularly happen, Brexit event could be the interesting factor that might be discovered something different from prior studies in US stock market.

Refer to (Galariotis et al., 2007), they studied contrarian and momentum profitability during 1964 to 2005 in London Stock Exchange where this stock market was a supremely significant market to research as it was the largest non-US stock market by turnover at that period. Particularly in great event, (Arshad et al., 2020) studied impact on Brexit Vote on London Stock Exchange. The event study covered prior to Brexit Vote, representing Brexit vote period and eventually the referendum to leave EU on 23 June 2016. The result found that there was higher volatility before Brexit Vote than during or after for London Stock Exchange. While overall volatility decreased in various sectors, some sectors behaved differently. The efficient of London Stock Market deteriorated during the uncertainty of Brexit Vote. (Adesina, 2017) found that implied volatility in financial market increased with increasing political uncertainty in which she examined based on Brexit Vote event. In addition, (Bozos et al., 2011), found that there were positive and significant average abnormal stock price returns around dividend and earning announcement which were simultaneously released.

Following (Chung & Louis, 2017), we constructed straddle option on the first day in each month. Straddle option would be at-the-money in call option and put option that all expire in next month. We calculated return by holding straddle position till expiration date preventing from two-way transaction. Being concerned of liquidity, we choose option that mostly have open interest to ensure that the return is the result of trading at market price and not due to short-term illiquidity. Unlike (Chung & Louis, 2017) which constructed portfolio of straddle options categorized into BEFORE_EA, AFTER_EA, and NON_EA, with changing number of underlying stocks in each month, we simply use panel data analysis to find the effect of before announcement straddle option return. Despite the difference in method, we hope to find similar result that earning announcement effect really exist. According to (Chung & Louis, 2017), BEFORE_EA portfolio provided positive average return around 5.1% while AFTER_EA portfolio provided more negative return than NON_EA portfolio. The logic behind was investors in option underestimate future volatility before earning announcement and overestimate future volatility after earning announcement according to recency bias.

While (Chung & Louis, 2017) studied in U.S. equity option market, (Wang et al., 2021) found that firms with a high degree of return asymmetry (larger absolute value of skewness) are highly illiquid. Then, we use underlying in FTSE 100 accordingly to confidence adequate liquidity. Consistent with the pervious study, (Angelidis & Andrikopoulos, 2010) found evidence of asymmetric spill over that volatility would spill over from large to small-cap stocks which studied in London Stock Exchange. Then, we would follow (Chung & Louis, 2017) to examine the research question that straddle option could generate return before earning announcement in London Stock Exchange. The recency bias which found in (Chung & Louis, 2017) in U.S. equity option market would whether found in London Stock Exchange. There could be political uncertainty after Brexit vote affected and would whether change the result differently from previous studies.

Literature Review

The option trader could yield from both price and volatility. To yield return from option, investors need to predict future volatility and input those number correctly. Nevertheless, forecasting volatility is the tough task which investors are rarely done perfectly. (Goyal & Saretto, 2009) quoted that "volatility misestimation is the most obvious source of option mispricing". Regard to various researches, measurement and forecast of volatility is a mean-reversion. Refer to (Black & Scholes, 1973), implied volatility (IV) from an option on a stock would, on average, mirror future volatility and nearly to its long-run average historical volatility (HV). However, huge deviation of IV from HV that could cause option mispricing. (Goyal & Saretto, 2009) sorted stock by the difference between HV and IV. They used closet to at the money (ATM) option to ensure adequate liquidity and properly reflect IV. Consequently, the result was shown that zero-cost trading strategy by longing position in portfolio with a large positive difference between HV and IV and shorting position in portfolio with a large negative difference could generate statistically and economically significant return. Being analyzed transaction cost, it could decrease straddle option around 3.9% per month. However, there could not obliterate economically profit from portfolio. The key logic behind deviation is investor overreact to recent situation then increasing their forecasting of future volatility after negative stock return and decreasing their forecasting of future

volatility after positive stock returns which induce temporary deviation of IV from HV. The overreaction to recent stock return induces to misestimation of future volatility which related to behavioral model of (Barberis et al., 2001) that investors preference depends on gain and loss in wealth comparing to absolute level of wealth. In addition, they are more sensitive to loss rather than gain in portfolio due to loss aversion and further found that if a stock had a favorable prior performance then investor would less aware about future loss on this stock which alleviate by previous gain. The perception of this kind of stock seem less risky than before in investor' perspective. According to empirical test, return on option on high volatility (HV) stocks are higher than those low HV stocks consistent with irrational investors' behavior that overreact to recent information and unforeseen long-run mean reversion in implied volatility. (Goyal & Saretto, 2009) also studied around earning announcement period and found skyrocket of IV in that time. To ensure result not be affected by earning announcement, they remove observations that related that period and found that not significant impact on the result.

To broaden knowledge profoundly, (Chung & Louis, 2017) focused on particularly event that spurring stock return volatility up which was earning announcement. Various studies found that incoming investor around earning announcement in option typically unsophisticated investor which probably less knowledge in option trading refer to (Lemmon & Ni, 2011). Then, they studied whether stock option could be predictable around earning announcement. However, investor could rarely forecast upcoming situation and properly measure short term impact. The frequently released event that could surely affect volatility is earning announcement which could result to forecastable stock return. Nonetheless, there are some argument that investor in option market could potentially sophisticate according to (Patell & Wolfson, 1979). Another research, (Jin et al., 2012), also found that option investor could have information advantage before earning announcement.

(Chung & Louis, 2017) followed (Goyal & Saretto, 2009) to further examine the uncovered reason behind the research question by forming straddle at-the-money both call and put option at the first trading day after the option expiration date in each month which forming option need to expire in next month. The holding

till expiration would be implemented to calculate option return to avoid two transactions. Being concerned liquidity, chosen option need to have open interest. Consequently, they sort straddle option into three groups each month. The first group consist of straddle constructed within 15 trading days after earning announcement (Called, AFTER_EA portfolio). The second group consist of straddle constructed within 15 trading days ending three days before earning announcement (Called, BEFORE_EA portfolio). The third group consist of straddle constructed on company that have earning announcement neither in the month before nor in the month after the portfolio constructed date (Called, the NON_EA portfolio). They found intense earning announcement effect. AFTER_EA portfolio yielded a negative return while BEFORE_EA portfolio yielded a positive return. Being implemented a trading strategy, both buy the BEFORE_EA portfolio and selling AFTER_EA portfolio earned average return 14.4% over one-month period comparing with average negative return on straddle option according to (Coval & Shumway, 2001). Obviously, option investors overestimate future volatility after recent earning announcement and underestimate future volatility before earning announcement.

(Chung & Louis, 2017) also examine difference of volatility which could be affected by option investors inability to forecast volatility properly and aware of mean-reversion knowledge. They found that earning announcement and volatility spread effect are distinct and increasing individually. In addition, return from two-way strategy that constructed straddle by buying BEFROE_EA portfolio which was in top difference HV and IV quintile could yield higher and consequently incorporate with constructed both buying BEFORE_EA portfolio that fall in top HV-IV quintile and sell AFTER_EA portfolio that fall in bottom HV-IV quintile could yield superior return, called hedge return from two-way strategy.

Regard to the result, the logic behind would relate some bias that investors would overreact to recent volatility according to happening situation. The recency bias would be mentioned in behavioral psychology literature refer to (Tversky & Kahneman, 1973). In addition, even sophisticated investors could be potentially affected by the recency bias which induce to underestimate incoming volatility before earning announcement and then underprice straddle option and

overestimate recent volatility after earning announcement and then overprice straddle option. The recency bias would describe that investors seem to overweight most recent experience.

Not only earning announcement event would accelerate the stock return volatility, but also political uncertainty like Brexit Vote that affected economic confidence and frighten stock market which could probably result to spike in volatility. Supporting the notion, (Adesina, 2017) found that implied volatility in financial market rose with increasing political uncertainty. However, (Arshad et al., 2020) found that overall volatility deteriorated due to Brexit Vote. Oil & Gas and Financial sectors' volatility deteriorated while Banking, Technology and Real Estate sector rising in volatility. In addition, British stock market efficiency gradually decreased among uncertainty of Brexit Vote.

The sample data which was stock price in London Stock Exchange during 1 March 2015 to 30 April 2018 would be separate into three period around Brexit Vote. First, before Brexit Vote event which was during 1 March 2015 to 28 February 2016. Second, during 1 March 2016 to 31 May 2017 which was Brexit Vote period. Particularly, 23 June 2016 was the referendum happening and the result was 51.9% to leave EU. Third, during 1 June 2017 to 30 April 2018 which was post-Brexit Vote period. In addition, volatility in London Stock Exchange was higher before Brexit Vote than during or post-Brexit Vote and altogether found less efficient among uncertainty period during Brexit Vote.

Regard to stock price might not always be reflected by logical reaction, there probably influenced by cognitive biases. This bias played an important role in stock price implication that could potentially cause mispricing. Cognitive biases would be conservatism and representativeness. (Kariofyllas et al., 2017) examine behavioral pattern which investor be influenced by cognitive biases in London Stock Exchange that could result to market inefficiency. Cognitive biases affected information processing about trend and consistency. Representative bias could exist due to consistency of prior performance resulting to overreaction while conservatism could exist due to lack of consistency existence resulting underreaction.

The data be used covering over 1980 to 2012 in London Stock Exchange which be influenced by various financial uncertainty and Great financial crisis in 2007. They found that, over the long-term period, investor would be influenced by representativeness and conservatism bias which could induce investor to generate biased expectation of future company performance. Particularly, financial sector in UK is an international center for all kind of investor and crucially with implementation of Bank of England quantitative easing strategy. In addition, they found that investor overreaction with trend reversely. Past financial performance would induce higher reversal than momentum. Lastly, investor behavior strategies would be a smoother trend among stress period.

Research Methodology

- Earning announcement effect on straddle option return

In general, stock price volatility would spike around earning announcement period which we calculated by daily absolute stock return. We would focus the spike on earning announcement date and the following day. (Chung & Louis, 2017) found that stock price volatility gradually increasing before a few days prior announce date and a few days after announcing. Whenever absolute stock price change, it would induce to increase in straddle option return. Earning announcement is the great influencer which induce a large change in stock price. Regard to underestimate future volatility in upcoming announcement date, investors could generate return by constructing straddle return before earning announcement.

- Constructing straddle and return calculation

We follow the method suggested by (Chung & Louis, 2017). Each month, on the first trading day, we construct straddle option with at-the-money (ATM) one pair which are call and put option that expire in next month. Regard to ATM options are most liquid and their implied volatility are approximately most accurate calculating of future realized volatility over the life of the option. While

perfect ATM option rarely exist, we use nearest-the-money options with the same strike on the straddle constructing date that the moneyness are mostly between 0.90 and 1.10. According to option transaction price are not readily available, following (Chung & Louis, 2017), we calculate straddle option return by using mid-point of bid and offer prices, option strike price, and the stock price on last trading date before expiration. Using following formula as below

$$Return = \frac{Absolute\ value\ (Stock\ price\ at\ expiration - Strike) - (Call\ price + Put\ price)}{Call\ price + Put\ Price}$$

- Straddle returns and earning announcements.

We calculate the straddle option monthly returns of each underlying companies over 3 years to use in the panel data analysis. To uncover the answer whether we could generate straddle option return before earning announcement in London, we use the panel regression equation as below.

$$STRAD\_RET_{it} = B_0 +\ B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + \varepsilon_{it}$$

Where STRAD_RET is the straddle option return; constant is the baseline straddle option return; BEFORE_EA is the dummy variable taking the value 1 for the BEFORE_EA portfolio be constructed within 15 trading days ending three days before earning announcement; HV-IV is the log difference of historical volatility (HV) and implied volatility (IV) measured each month at the time of the straddle option constructed; and the subscription i refer to company and t refer to month.

Our hypothesis is below.

$H_0: B_1 = 0$ and $H_a: B_1 > 0$

The hypothesis that straddle option portfolio be constructed before earning announcement could whether generate return additional from the baseline (non-announcement period). We expect B_1 to be significantly positive which means that straddle option be constructed within 15 trading days ending 3 days before earning announcement could generate return additional from the baseline (non-announcement period). Regarding to (Chung & Louis, 2017), studies in U.S. equity option market, the BEFORE_EA portfolio yielded average return of 5.1% (t-value

= 3.09), while AFTER_EA portfolio yielded average return of -9.3% (t-value = -5.12) and lastly NON_EA portfolio yielded average return of -3.1% over the month holding period. It probably inferred that investors could not perfectly adjust implied volatility before earning announcement despite knowing earning announcement event induced volatility spike and downward after announcement. Subsequently, we could generate straddle option return by constructing straddle option within 15 trading days ending three days before earning announcement in U.S. equity option market refer to (Chung & Louis, 2017). Then we would see the result from this study whether we could generate straddle option return before earning announcement in London.

To further study our straddle option returns before earning announcement, we will add B_3SIZE_{it}, B_4COV_{it} , B_5FR_{it} and interaction term which are $B_6BEFORE\_EA * SIZE_{it}$, $B_7BEFORE\_EA * COV_{it}$ and $B_8BEFORE\_EA * FR_{it}$. The panel regression equation as below.

$$STRAD\_RET_{it} = B_0 + B_1BEFORE\_EA_{it} + B_2HV - IV_{it} + B_3SIZE_{it}$$
$$+ B_4COV_{it} + B_5FR_{it} + B_6BEFORE\_EA * SIZE_{it}$$
$$+ B_7BEFORE\_EA * COV_{it} + B_8BEFORE\_EA * FR_{it} + \varepsilon_{it}$$

Where SIZE is the natural logarithm of the market capitalization of the company measured each month at the time of the straddle option constructed. This additional interaction term will explain more how company's size affects the straddle option portfolio returns be constructed within 15 trading days ending three trading days before earing announcement; COV is number of earning forecast by analysts measured each month at the time of the straddle option constructed. Second additional interaction term will explain more the number of analyst coverage of underlying affects the straddle option portfolio returns be constructed within 15 trading days ending three trading days before earing announcement; FR is a free float ratio calculated by free float as a percentage of shares outstanding of the company measured each month at the time of the straddle option constructed. Third additional interaction term will explain more a free float ratio of stock affects the straddle option portfolio returns be constructed within 15 trading days ending three trading days before earing announcement.

Our second hypothesis is below.

$H_0: B_6 = 0$ and $H_a: B_6 < 0$

We expect B_6 to be significantly negative which means that bigger size of the underlying companies did have negative effect on the straddle option returns constructed before earning announcement period additional from baseline straddle option returns. On the other hand, smaller size of the underlying companies has less negative effect on the straddle option returns additional from baseline straddle option returns. According to various studies, option investors have less information in smaller underlying companies and altogether less publicly provided research studies from institution due to underlying's popularity. They rather speculate by less informed investing and probably result to adjust less to implied volatility of straddle option in smaller underlying company's size prior earning announcement period. Knowing this result, we could construct straddle option portfolio which only focus on specifically smaller underlying company's size that could yield higher option straddle returns and probably create more option investment strategy according this founding.

Our third hypothesis is below.

$H_0: B_7 = 0$ and $H_a: B_7 < 0$

We expect B_7 to be significantly negative which means increasing number of analyst coverage of underlying decreases the straddle option return before earning announcement. The logic behind is analyst coverage could provide firm performance and other information which enhance investment decision. Then investors could obtain more accurate information to firm valuation and deteriorate equity valuation mispricing. In conclusion, analyst coverage could decrease information asymmetry refer to (Li, 2020) which is the one reason that investors underestimate upcoming event and result to input lower implied volatility before earning announcement to straddle option. According to this finding, we probably could focus only underlying which has less analyst coverage to yield higher return from constructing straddle option before earning announcement.

Our fourth hypothesis is below.

$H_0: B_8 = 0$ and $H_a: B_8 < 0$

We expect B_8 to be significantly negative which means higher free float ratio would decrease the straddle option return before earning announcement. The logic behind is stock with higher free float ratio would lead to higher average daily closing price and trading activity including increase price volatility refer to (Bostani & Kilic, 2010). Regarding to generate return by constructing straddle option prior earning announcement mainly from investors underestimate and adjust less to implied volatility, stock with higher free float ratio probably trigger investors to adjust higher volatility to straddle option before earning announcement and result to generate lower straddle option return. This result could lead to stock picking strategy mainly focus on stock with lower free float ratio to construct straddle option before earning announcement.

Sample and data sources

We use sample in period from January 2018 to November 2020 in London Stock Exchange. Source that we used to calculate the straddle option return came from Datastream. The option data for constructing straddle included daily bid and ask quotes, strike price, moneyness and implied volatility. Stock return, historical volatility, market capitalization, number of earning forecast by analysts, free float ratio and earning announcement date of stocks in FTSE 100 came from Bloomberg Terminal. According to prior studies, we followed (Chung & Louis, 2017) to reduce information error by (1) option offer price be greater than bid price and bid price be greater than £0; (2) implied volatility of the option be available; and (3) option contracts mostly have open interest to ensure adequate liquidity. The filtering process provides 1,616 straddle option which are pairs of call and put options for 57 stocks.

Table 1

Coverage ratio of stock and straddle option

Panel A: Stock coverage ratio	No. of Stock	Coverage ratio
Available historical option data	57	56.44%
FTSE100 as of 31 Dec 2020	101	100.00%

Panel B: Straddle option construction ratio	Straddle option	Construction ratio
Actual historical option data available	1,616	81.00%
Expected construct for 57 stocks for 3 years (35 months)	1,995	100.00%

Panel C: Straddle option before earning announcement ratio	Straddle option	BEFORE_EA ratio
Straddle option be constructed within 15 trading days ending 3 days before earning announcement	152	9.41%
Total straddle option be constructed	1,616	100.00%

Summary statistics

Table 1 reports coverage ratio of stock and straddle option. The stock coverage ratio, which is shown in Panel A, illustrates that we could get available historical option data for 57 stocks from total 101 stocks as a member of FTSE 100 as of 30 December 2020 which cover at 56.44%. The reason is the limitation of available historical option data from Datastream. Straddle option coverage ratio, which is shown in Panel B, illustrates that we could construct 1,616 straddle option from expected 1,995 straddle option be constructed 57 stocks for 3 years which cover at 81% due to filtering process to construct straddle option. Straddle option before earning announcement ratio, which is shown in Panel C, illustrates that straddle option be constructed within 15 trading days before earning announcement are 152 which be calculated at 9.41% of total straddle option be constructed.

Table 2

Year and quarter distribution of observation

	Observation	Percentage
Total of year 2018	**447**	**27.66%**
Qtr1	112	6.93%
Qtr2	109	6.75%
Qtr3	106	6.56%
Qtr4	120	7.43%
Total of year 2019	**599**	**37.07%**
Qtr1	132	8.17%
Qtr2	155	9.59%
Qtr3	156	9.65%
Qtr4	156	9.65%
Total of year 2020	**570**	**35.27%**
Qtr1	159	9.84%
Qtr2	155	9.59%
Qtr3	156	9.65%
Qtr4	100	6.19%
Total observation for 3 years	**1,616**	**100.00%**

Table 2 reports the year and quarter distribution of observation. The weight of observations is highest in 2019 which is 37.07%, the second is 2020 at 35.27%, and the lowest is 2018 at 27.66%. The potential reason why in year 2018 is the lowest weight of observation is the members of FTSE 100 be recorded as 30 December 2020 which maybe not active and be the popular underlying for option trading in 2018. Then, this may cause year 2018 has lowest weight of observation.

Table 3 reports statistics on the straddle option returns, the stock returns, straddle option raw returns before earning announcement, historical volatility of underlying stock, implied volatility for call and put option of straddle option, market capitalization, number of earning forecast by analysts and free float ratio calculated by free float as a percentage of shares outstanding of the company measured each month at the time of the straddle option constructed. The statistics are the time-series average of the monthly cross-sectional means of the variables. The average straddle return is slightly positive, which is inconsistent with (Chung & Louis, 2017), who further study and found ATM straddle yield negative returns in general. They imply the negative straddle option return as a premium for risk which straddle option provide investors insurance against stock price volatility. The average stock return is positive in same direction with straddle option return. The interesting is straddle raw return before earning announcement could

generate return surprisingly higher than ordinary straddle option return and stock return. The historical volatility is less than implied volatility which could see slightly negative in HV-IV. The rest are statistics of market capitalization, number of earning forecast by analysts and free float ratio which would be the variables for additional hypothesis test.

Table 3 Summary statistics

We calculate cross-sectional mean of the variables each month and yield time-series statistic in the table. Straddle options are constructed each month on the first trading date with nearest-the-money call and put options that expiring the next month and be same strike price. The straddle option return is calculated by using mid-point of bid and offer prices, option strike price, and the stock price on last trading date before expiration which return calculation equation explained earlier in Constructing straddle and return calculation section. Stock return is the raw return of the stock over holding period same as straddle option. HV is the return volatility of the underlying stock over the year period before straddle option construction date, which is historical volatility. IV is the average implied volatility yielding from call and put of straddle option. HV-IV is the difference between the historical volatility and the implied volatility. SIZE is the market capitalization of the company measured each month at the time of the straddle option constructed (Unit: Million Pound Sterling). COV is number of earning forecast by analysts measured each month at the time of the straddle option constructed. FR is a free float ratio calculated by free float as a percentage of shares outstanding of the company measured each month at the time of the straddle option constructed. The sample includes 1,616 pairs of call and put options for 57 stocks. The sample period runs from January 2018 to November 2020.

	Mean	Std	Min	Median	Max
Straddle return	0.0097	0.8927	-1.0000	-0.2241	6.3150
Stock return	0.0115	0.1271	-0.3378	-0.0040	1.1143
BEFORE_EA raw return	0.1714	1.1345	-0.9970	-0.1428	4.8680
HV	0.2737	0.0959	0.1457	0.2442	0.7229
IV	0.2830	0.1196	0.1113	0.2530	1.6855
HV_IV	-0.0093	0.0819	-1.0416	-0.0017	0.2277
SIZE	34,822	44,825	2,591	13,618	223,132
COV	21.4115	5.4262	6.0000	20.0000	39.0000
FR	0.9260	0.1753	0.2248	0.9986	1.0000

Table 4 The straddle return be constructed within 15 trading days ending 3 days before earning announcement
The table present the results of the following equations for panel data in random effect model from January 2018 to November 2020:

$$STRAD\_RET_{it} = B_0 + B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + \varepsilon_{it} \quad \text{---- (2 Variables)}$$

$$STRAD\_RET_{it} = B_0 + B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + B_3 SIZE_{it} + B_4 COV_{it} + B_5 FR_{it} + B_6 BEFORE\_EA * SIZE_{it} + B_7 BEFORE\_EA * COV_{it} + B_8 BEFORE\_EA * FR_{it} + \varepsilon_{it} \quad \text{---- (8 Variables)}$$

(2 Variables) , *BEFORE_EA* is the dummy variable taking the value 1 for the *BEFORE_EA* portfolio constructed within 15 trading days ending three days before earning announcement; *HV-IV* is the log difference of historical volatility (HV) and implied volatility (IV) measured each month at the time of the straddle option constructed; and the subscription i refer to company and t refer to month. The sample includes 1,616 pairs of call and put options for 57 stocks. We run panel data for each of the 35 months and each stock from January 2018 to November 2020 with Random effect model and Fixed effect model. Finally, we choose Random effect model from P-value of Hausman test greater than 0.10

(8 Variables) , *BEFORE_EA* is the dummy variable taking the value 1 for the *BEFORE_EA* portfolio constructed within 15 trading days ending three days before earning announcement; *HV-IV* is the log difference of historical volatility (HV) and implied volatility (IV) measured each month at the time of the straddle option constructed. *SIZE* is the natural logarithm of the market capitalization of the company measured each month at the time of the straddle option constructed. *COV* is number of earning forecast by analysts measured each month at the time of the straddle option constructed. *FR* is a free float ratio calculated by free float as a percentage of shares outstanding of the company measured each month at the time of the straddle option constructed. The sample includes 1,616 pairs of call and put options for 57 stocks. We run panel data for each of the 35 months and each stock from January 2018 to November 2020 with Random effect model and Fixed effect model. Finally, we choose Random effect model from P-value of Hausman test greater than 0.10

VARIABLES	(2 Variables) STRAD_RET	(8 Variables) STRAD_RET
BEFORE_EA	0.177***	-0.019
	(2.350)	(-0.030)
HV-IV	0.939***	0.874***
	(4.140)	(3.790)
SIZE		0.0380*
		(1.430)
COV		-0.0122**
		(-2.260)
FR		-0.00006
		(-0.050)
BEFORE_SIZE		-0.0204
		(-0.230)
BEFORE_COV		0.0272*
		(1.470)
BEFORE_FR		-0.00199
		(-0.470)
Constant	0.00134	-0.10157
	(0.0606)	(-0.450)
Observations	1,616	1,616
Number of STOCK_ID	57	57

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results

- Straddle return before earning announcement with *HV-IV*
  (2 variables)

To investigate straddle option be constructed within 15 days ending 3 days before earning announcement could generate additional return from baseline, The panel regression equation as below:

$$STRAD\_RET_{it} = B_0 + B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + \varepsilon_{it}$$

Where *STRAD_RET* is the straddle option return; constant is the baseline straddle option return; *BEFORE_EA* is the dummy variable taking the value 1 for the *BEFORE_EA* portfolio constructed within 15 trading days ending three days before earning announcement; *HV-IV* is the log difference of historical volatility (HV) and implied volatility (IV) measured each month at the time of the straddle option constructed; and the subscription i refer to company and t refer to month.

The sample includes 1,616 pairs of call and put options for 57 stocks. We run panel data for each of the 35 months and each stock from January 2018 to November 2020 with Random effect model and Fixed effect model. Finally, we choose Random effect model from P-value of Hausman test greater than 0.10

The results are reported in Table 4 under column (2 Variables). The coefficient on *BEFORE_EA* captures the straddle option return additional from the baseline (non-announcement period) which be constructed within 15 trading days ending three days before earning announcement. The coefficient on *HV-IV* captures the straddle option return additional from the baseline (non-announcement period) from log difference of historical volatility (HV) and implied volatility (IV) measured each month at the time of the straddle option constructed.

As presented under column (2 Variables), the *BEFOR_EA* portfolio yields average straddle option return additional from the baseline (non-announcement period) of 17.7% (z-value = 2.350) over the holding period at significant level 1% which consistent with (Chung & Louis, 2017). *HV-IV* yield average return of 0.939% (z-value = 4.140) at significant level 1% which consistent with (Goyal & Saretto, 2009). These results provide strong evidence that we could generate return additional from the baseline (non-announcement period) by constructing

straddle option within 15 trading days ending 3 days before earning announcement period and we could generate return additional from the baseline (non-announcement period) by choosing the straddle option that have a difference of historical volatility from implied volatility. In general, option traders adjust implied volatility reflected in option premiums around earning announcement date; they adjusting the implied volatility upward predicting the uncertainty before the announcement, and downward after the announcement refer to (Chung & Louis, 2017). Nevertheless, our results show that the adjusted volatility was still underestimated before the earning announcement.

- Straddle return before earning announcement with *BEFORE_SIZE, BEFORE_COV and BEFORE_FR* (8 variables)

To further study our straddle option returns before earning announcement, we will add $B_3 SIZE_{it}$, $B_4 COV_{it}$, $B_5 FR_{it}$ and interaction term which are $B_6 BEFORE\_EA * SIZE_{it}$, $B_7 BEFORE\_EA * COV_{it}$ and $B_8 BEFORE\_EA * FR_{it}$. The panel regression equation as below.

$$STRAD\_RET_{it} = B_0 + B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + B_3 SIZE_{it}$$
$$+ B_4 COV_{it} + B_5 FR_{it} + B_6 BEFORE\_EA * SIZE_{it}$$
$$+ B_7 BEFORE\_EA * COV_{it} + B_8 BEFORE\_EA * FR_{it} + \varepsilon_{it}$$

Where *STRAD_RET* is the straddle option return; constant is the baseline straddle option return; *BEFORE_EA* is the dummy variable taking the value 1 for the *BEFORE_EA* portfolio constructed within 15 trading days ending three days before earning announcement; *HV-IV* is the log difference of historical volatility (HV) and implied volatility (IV) measured each month at the time of the straddle option constructed. *SIZE* is the natural logarithm of the market capitalization of the company measured each month at the time of the straddle option constructed. *COV* is number of earning forecast by analysts measured each month at the time of the straddle option constructed. *FR* is a free float ratio calculated by free float as a percentage of shares outstanding of the company measured each month at the time of the straddle option constructed; the subscription i refer to company and t refer to month.

The sample includes 1,616 pairs of call and put options for 57 stocks. We run panel data for each of the 35 months and each stock from January 2018 to November 2020 with Random effect model and Fixed effect model. Finally, we choose Random effect model from P-value of Hausman test greater than 0.10

The results are reported in Table 4 under column (8 Variables). The coefficient on *HV-IV* captures the log difference of historical volatility (HV) and implied volatility (IV) or the volatility spread that affects the straddle return. The additional straddle return from *HV-IV* is 0.874% (z-value = 3.790) and significant at 1% confidence level meaning that a 1% increase in volatility spread, either from implied volatility decrease while keeping historical volatility constant or the historical volatility increase while keeping implied volatility constant, would increase straddle return 0.874% additional from the baseline. The coefficient on *SIZE* captures the impact of natural logarithm of the market capitalization of the company to the straddle return. The additional straddle return from *SIZE* is 0.038% (z-value = 1.430) and significant at 10% meaning that an increase of 1% in *SIZE* would increase straddle return 0.038% additional from the baseline. This seems to contradict with our expectation that *SIZE* should negatively affect straddle return as larger firms are often expected be more transparent regarding financial information which helps reducing the misestimation of implied volatility. Nevertheless, the coefficient on *SIZE* is only 0.038% which would rarely generate economically significant profit in the actual investment practice. The coefficient on *COV* captures number of earning forecast by analysts that affect the straddle return. The additional straddle return from *COV* is -1.22% (z-value = -2.260) and significant at 5% level meaning that one additional increase in *COV* would decrease straddle return by 1.22%. This is consistent with our expectation that more information analysts provide to investors, the less degree of option mispricing and thus would decrease the straddle abnormal return. The coefficient on *FR* captures free float of underlying that affect the straddle return. The additional straddle return from *FR* is -0.006% (z-value = -0.050) which is not significant and there is no strong evidence that this variable could generate additional straddle return.

Moving on to the terms involving the interaction of variables and *BEFORE_EA*, the coefficient on *BEFORE_SIZE* captures the straddle option return additional from the baseline (non-announcement period) be constructed within 15 days ending 3 days before earning announcement from the natural logarithm of the market capitalization of the company. The coefficient on *BEFORE_FR* captures straddle option return additional from the baseline (non-announcement period) be constructed within 15 days ending 3 days before earning announcement from free float ratio of the company. The additional straddle return from *BEFORE_SIZE* is -0.0204% (z-value = -0.230) and *BEFORE_FR* is -0.19% (z-value = -0.470) which are not significant and there are no strong evidence that these 2 variables could explain generating straddle option return be constructed within 15 days ending 3 days before earning announcement. Furthermore, there are not enough evidence to support that bigger size of the underlying companies and higher free float ratio did have negative effect on the straddle option returns additional from the baseline (non-announcement period) be constructed within 15 days ending 3 days before earning announcement. Lastly, the coefficient on *BEFORE_COV* captures straddle option return additional from the baseline (non-announcement period) be constructed within 15 days ending 3 days before earning announcement from number of earning forecast by analysts. The additional straddle return from *COV* is 2.72% (z-value = 1.470) and significant at 10% meaning that additional *COV* would increase straddle return 2.72% from constructing straddle option within 15 days ending 3 days before earning announcement. Surprisingly, the coefficient for *BEFORE_COV* turns out to be the opposite of what expected in our 3rd hypothesis. According to (Li, 2020), analyst coverages decrease information asymmetry, and in general should improve the accuracy of the forecast stock price volatility. Therefore, the more information analysts provide to investors, the less abnormal return in the straddle strategy. Since the coefficient for *BEFORE_COV* is positive, it is possible that, in our data, analysts provide biased information before earning announcement which causes more mispricing in the options and result in more straddle return as they expire.

Robustness test

Table 5 reports that average return of straddle option be constructed within 10 days ending 3 days before earning announcement yield 15.75% which lower than being constructed within 15 days before earning announcement at 17.14%. In addition, average return of straddle option be constructed within 21 days ending 3 days before earning announcement yield 13.89% which lower than being constructed within 15 days before earning announcement at 17.14%. Nevertheless, straddle option be constructed before earning announcement have similar behavior that they could generate a positive return. We would like to test further that different days before earning announcement could whether generate positive return significantly. Then we regress panel data and receive result as below.

Table 5 Mean straddle return, stock return and mean straddle raw return of different period before earning announcement

We further calculate cross-sectional mean of the straddle option which be constructed in different days before earning announcement which be 10 days and 21 days to compare each other and compare with baseline straddle option return and stock return. The sample includes 1,616 pairs of call and put options for 57 stocks. The sample period runs from January 2018 to November 2020.

	Straddle return	Stock return	BEFORE_EA 10 days	BEFORE_EA 15 days	BEFORE_EA 21 days
Average raw return for 3 years	0.0097	0.012	0.1575	0.1714	0.1389

- Straddle return be constructed 10 days before earning announcement
    - with *HV-IV* (2 variables)

As presented in Table 6 under column (2 Variables), the *BEFOR_EA* portfolio yields average straddle option return additional from the baseline (non-announcement period) of 15.1% (z-value = 1.720) over the holding period at significant level 5%. *HV-IV* yield average return of 0.933% (z-value = 4.110) at significant level 1%

Table 6 The straddle return be constructed within 10 trading days ending 3 days before earning announcement
The table present the results of the following equations for panel data in random effect model from January 2018
to November 2020:

$$STRAD\_RET_{it} = B_0 + B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + \varepsilon_{it} \quad \text{---- (2 Variables)}$$

$$STRAD\_RET_{it} = B_0 + B_1 BEFORE\_EA_{it} + B_2 HV - IV_{it} + B_3 SIZE_{it} + B_4 COV_{it} + B_5 FR_{it} + B_6 BEFORE\_EA * SIZE_{it} + B_7 BEFORE\_EA * COV_{it} + B_8 BEFORE\_EA * FR_{it} + \varepsilon_{it} \quad \text{---- (8 Variables)}$$

VARIABLES	(2 Variables) STRAD_RET	(8 Variables) STRAD_RET
BEFORE_EA	0.151**	1.000
	(1.720)	(1.200)
HV_IV	0.933***	0.864***
	(4.110)	(3.740)
SIZE		0.0429*
		(1.630)
COV		-0.0111**
		(-2.070)
FR		0.00011
		(0.080)
BEFORE_SIZE		-0.0849
		(-0.800)
BEFORE_COV		0.0156
		(0.710)
BEFORE_FR		-0.00386
		(-0.830)
Constant	0.00771	-0.18473
	(0.340)	(-0.820)
Observations	1,616	1,616
Number of STOCK_ID	57	57

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Straddle return be constructed 21 days before earning announcement
  o with *HV-IV* (2 variables)

As presented in Table 7 under column (2 Variables), the *BEFOR_EA* portfolio yields average straddle option return additional from the baseline (non-announcement period) of 14.9% (z-value = 2.220) over the holding period at significant level 5%. *HV-IV* yield average return of 0.938% (z-value = 4.120) at significant level 1%

Table 7 The straddle return be constructed within 21 trading days ending 3 days before earning announcement
The table present the results of the following equations for panel data in random effect model from January 2018
to November 2020:

$$STRAD\_RET_{it} = B_0 + B_1BEFORE\_EA_{it} + B_2HV - IV_{it} + \varepsilon_{it} \quad ---- \text{ (2 Variables)}$$

$$STRAD\_RET_{it} = B_0 + B_1BEFORE\_EA_{it} + B_2HV - IV_{it} + B_3SIZE_{it} + B_4COV_{it} + B_5FR_{it} + B_6BEFORE\_EA * SIZE_{it} + B_7BEFORE\_EA * COV_{it} + B_8BEFORE\_EA * FR_{it} + \varepsilon_{it} \quad ---- \text{ (8 Variables)}$$

VARIABLES	(2 Variables) STRAD_RET	(8 Variables) STRAD_RET
BEFORE_EA	0.149**	-0.286
	(2.220)	(-0.430)
HV_IV	0.938***	0.864***
	(4.120)	(3.720)
SIZE		0.0369*
		(1.310)
COV		-0.0119**
		(-2.080)
FR		-0.00016
		(-0.120)
BEFORE_SIZE		0.0251
		(0.320)
BEFORE_COV		0.0142
		(0.870)
BEFORE_FR		-0.00118
		(-0.300)
Constant	-0.00016	-0.09123
	(-0.010)	(-0.380)
Observations	1,616	1,616
Number of STOCK_ID	57	57

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

o with *BEFORE_SIZE, BEFORE_COV and BEFORE_FR*
(8 variables)

As presented in Table 7 under column (8 Variables), the additional straddle return from *BEFORE_SIZE* 0.0251% (z-value = 0.320), *BEFORE_COV* 1.42% (z-value = 0.870) and *BEFORE_FR* -0.11% (z-value = -0.300) are not significant and there is no strong evidence that these 3 variables could explain straddle option return.

Table 8 reports year and quarter distribution of mean straddle return, stock return, and mean straddle return be constructed within 15 days ending 3 days before earning announcement. Average straddle option returns be constructed within 15 days ending 3 days in year 2020 only is 69.61% which much higher

comparing to average return for 3 years at 17.14%. While comparing in the same year of 2020, average straddle option returns be constructed within 15 days ending 3 days before earning announcement is 69.61% higher than baseline straddle option return at 17.47% and higher than stock return at 2.2%. The reason behind is COVID-19 pandemic in 1st quarter of 2020 resulting to a panic sell on FTSE 100 as you could see in Figure A. Consequently, average straddle option returns be constructed within 15 days ending 3 days before earning announcement in 1st quarter of 2020 is extraordinarily high at 196.58%.

- Straddle return be constructed 15 days before earning announcement only in year 2020
    o with *HV-IV* (2 variables)

As presented in Table 9 under column (2 Variables), the *BEFOR_EA* portfolio yields average straddle option returns additional from the baseline (non-announcement period) of 56.1% (z-value = 3.330) over the holding period at significant level 1%. *HV-IV* yield average return additional from the baseline (non-announcement period) of 0.838% (z-value = 2.070) at significant level 5%. These results provide strong evidence that we could generate return additional from the baseline (non-announcement period) by constructing straddle option within 15 trading days ending 3 days only in year 2020 before earning announcement period and we could generate additional return additional from the baseline (non-announcement period) by choosing the straddle option that have a difference of historical volatility from implied volatility. The reason behind average

straddle option returns additional from the baseline (non-announcement period) in year 2020 of 56.1% is the COVID-19 pandemic which induce the huge collapse in FTSE 100 during 1st quarter of year 2020 resulting to average straddle option returns additional from the baseline (non-announcement period) in 1st quarter in year 2020 at 196.58%, while the stock return in same period is 20.4%.

Table 8
Year and quarter distribution of mean straddle return, stock return and mean straddle
return be constructed within 15 days ending 3 days before earning announcement

	Mean straddle return	Mean straddle return BEFORE_EA 15 days	Mean stock return
Average of year 2018	**-0.0352**	**-0.1017**	**0.020**
Qtr1	-0.0768	-0.2000	0.022
Qtr2	-0.0008	0.2684	-0.022
Qtr3	0.0309	-0.0934	0.041
Qtr4	-0.0859	-0.3365	0.036
Average of year 2019	**-0.1139**	**-0.1130**	**-0.005**
Qtr1	-0.1906	-0.2694	-0.031
Qtr2	-0.0896	0.2164	-0.005
Qtr3	0.0523	-0.1313	0.029
Qtr4	-0.2393	-0.1702	-0.017
Average of year 2020	**0.1747**	**0.6961**	**0.022**
Qtr1	1.0081	1.9658	0.204
Qtr2	-0.3644	-0.1492	-0.036
Qtr3	-0.2588	-0.1778	-0.013
Qtr4	0.3614	0.3611	-0.120
Average return for 3 years	**0.0097**	**0.1714**	**0.012**

Figure A: Historical chart of FTSE 100 from October 2019 to December 2020

FTSE 100 Historical Chart
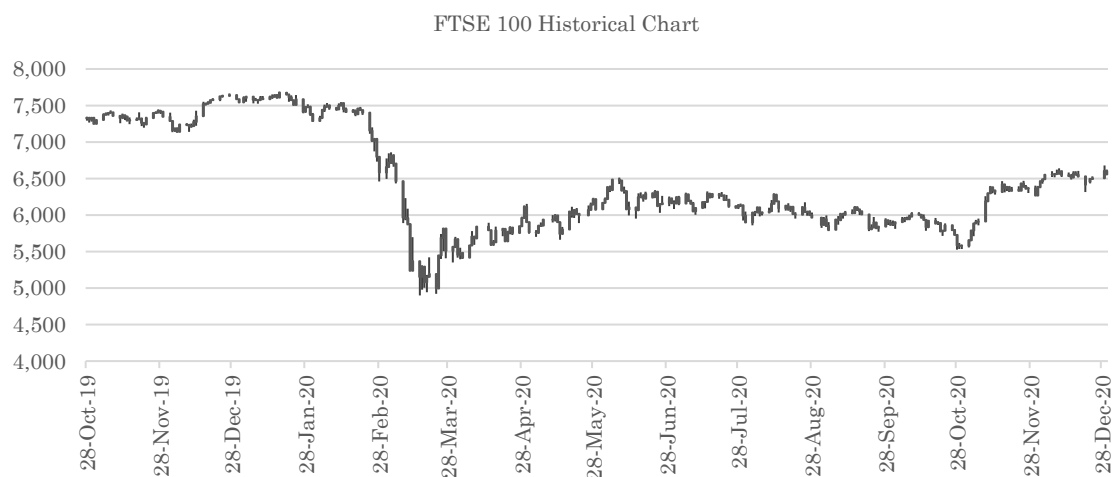
The straddle option provides investors insurance against stock price volatility refer
to (Chung & Louis, 2017), while benefit from stock price volatility though. In
conclusion, investors have no need to predict stock price direction and could benefit
from higher stock price volatility like panic sell from pandemic.

Table 9 The straddle return be constructed within 15 trading days ending 3 days before earning announcement only in year 2020

The table present the results of the following equations for panel data in random effect model from January 2020 to November 2020:

$$STRAD\_RET_{it} = B_0 + B_1BEFORE\_EA_{it} + B_2HV - IV_{it} + \varepsilon_{it} \quad \text{---- (2 Variables)}$$

$$STRAD\_RET_{it} = B_0 + B_1BEFORE\_EA_{it} + B_2HV - IV_{it} + B_3SIZE_{it} + B_4COV_{it} + B_5FR_{it} + B_6BEFORE\_EA * SIZE_{it} + B_7BEFORE\_EA * COV_{it} + B_8BEFORE\_EA * FR_{it} + \varepsilon_{it} \quad \text{---- (8 Variables)}$$

The sample includes 570 pairs of call and put options for 56 stocks. We run panel data for each of the 35 months and each stock from January 2018 to November 2020 with Random effect model and Fixed effect model. Finally, we choose Random effect model from P-value of Hausman test greater than 0.10

VARIABLES	(2 Variables) STRAD_RET	(8 Variables) STRAD_RET
BEFORE_EA	0.561***	-0.933
	(3.330)	(-0.530)
HV_IV	0.838**	0.787**
	(2.070)	(1.880)
SIZE		0.0922*
		(1.600)
COV		-0.0149
		(-1.130)
FR		0.00005
		(0.020)
BEFORE_SIZE		-0.0499
		(-0.210)
BEFORE_COV		0.0725*
		(1.580)
BEFORE_FR		0.00527
		(0.620)
Constant	0.12759***	-0.45422
	(2.480)	(-0.910)
Observations	570	570
Number of STOCK_ID	56	56

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- o with *BEFORE_SIZE, BEFORE_COV and BEFORE_FR* (8 variables)

As presented in Table 9 under column (8 Variables), the additional straddle return from *BEFORE_SIZE* -0.0499% (z-value = -0.210) and *BEFORE_FR* 0.527% (z-value = 0.620) are not significant and there is no strong evidence that these 2 variables could explain straddle option return. However, *BEFORE_COV* yields average straddle option returns additional from the baseline (non-announcement period) of 7.25% (z-value = 1.580) at significant level 10%. Although it's seems the coefficient is in the opposite way of our 3rd hypothesis that the coefficient should be negative, result provide evidence that we could generate return additional from

the baseline (non-announcement period) by constructing straddle option within 15 trading days ending 3 days before earning announcement period with increasing number of analyst coverage of underlying which similar to within 15 days ending 3 days before earning announcement for 3 years.

Conclusion

A trading strategy consisting of buying straddle option of company with upcoming earning announcement (the BEFORE_EA portfolio) yields a significant average return. The volatility spread effect (HV-IV) is distinct from earning announcement effect consisting with (Chung & Louis, 2017). The two effects are both additive each other and complementary. Although number of earning forecast by analysts yields a significant average return before earning announcement, it's not consistent across all periods we investigate then we could not totally conclude that analyst coverage could generate return before earning announcement. Market capitalization of underlying company and free float ratio of underlying company have not enough evidence to explain generating straddle option return before earning announcement.

Deviation days of constructing straddle option within 15 days before earning announcement could still generate significantly positive return. Furthermore, constructing straddle option within 15 days before earning announcement only in year 2020 could generate a significantly extraordinary return due to spike in volatility from COVID-19 pandemic emerging in 1st quarter and resulting to panic sell in FTSE 100.

The evidence seems to occur due to a form of recency bias, which cause option traders to underestimate volatility of upcoming earning announcement period. Our results are consistent with (Chung & Louis, 2017), this confirms that the behaviors of option traders before earning announcement seem to be more universal at least in the developed market and with the most recent data.

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VITA

NAME   Thanawat Thangchadakorn

DATE OF BIRTH   14 January 1990

PLACE OF BIRTH   Samutprakarn

HOME ADDRESS   66/593 M.Fuengfa 2 Soi4 Teparak rd. Bangmuang Samutprakarn
10270