Low Risk, High Return: Improving Option Writing Performance with Put-Call Ratios

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Abstract

This study employs the put-call ratio (PCR) to enhance option writing performance. Unlike the conventional buy-write strategy, we fully invest in the market during high PCR periods and sell options to generate income only when the PCR is low, greatly reducing trade frequency. Utilizing index options in Taiwan, which stands out as one of the few global markets developing tradable products for covered call strategies, and where retail investors play a predominant role, our approach yields higher returns with lower risk compared to the market index and outperforms VIX-based conditional strategies. The findings remain robust across institutional investors' positions, various PCR definitions, and alternative writing strategies such as put-write, covered combo, or delta-hedged portfolios.

Keywords: Option Writing, Put-Call Ratio, Open Interest, Buy-Write, VIX

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Abstract

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1. Introduction

Amidst the rising popularity of options trading for portfolio diversification, the Chicago Board Options Exchange (CBOE) introduced the BuyWrite Index (BXM) in 2002. This hypothetical index involves holding a long-term S&P 500 stock portfolio while simultaneously selling one-month call options on the S&P 500. Unlike the S&P 500 portfolio, the BXM sacrifices potential excess profits from market rallies in exchange for gaining premiums, thereby widening the profit margin and reducing overall portfolio volatility. Whaley (2002) delves into the returns and risks associated with covered call strategies, highlighting improvements in the Sharpe and Sortino ratios.[1] Lakonishok et al. (2007) underscore covered call writing as the predominant option strategy in the U.S. market.[2] Furthermore, this strategy lends itself to passive management, enhancing its practicality and giving rise to tradable products such as the Global X S&P 500 Covered Call ETF (XYLD), Global X Nasdaq 100 Covered Call ETF (QYLD), and JPMorgan's Equity Premium Income ETF (JEPI).[3] These ETFs stand out for providing monthly dividends, impressive dividend yields, and low volatility.

Figelman (2008) introduces a theoretical framework that dissects the covered call strategy's performance into the risk-free rate, equity risk premium, and volatility risk premium. Likewise, Israelov and Nielsen (2015) decompose the buy-write portfolio into a mix of equity, cash, and a short straddle position. These decompositions highlight the benefit of high implied volatility for the covered call strategy, echoing Goyal and Saretto's (2009) assertion that selling options is profitable when implied volatility

[1] There are many subsequent papers supporting the performance of the buy-write strategy, such as Hill et al. (2006), Kapadia and Szado (2007), Che and Fung (2011), Israelov and Nielsen (2014, 2015), O'Connell and O'Grady (2014).
[2] Fahlenbrach and Sandås (2010) provide evidence that the covered call strategy is one of the most active option strategies on the FTSE-100 index, not just in the U.S. market.
[3] Up to June 2024, XYLD, QYLD, and JEPI boasted substantial fund assets, reaching 2.90 billion, 8.23 billion, and 33.45 billion, respectively.

exceeds historical levels. Malkiel et al. (2018) build on these insights, exploring enhancements to buy-write strategies through a conditional approach, selling options only when the VIX index is high. Their findings indicate that implied volatility consistently surpasses future realized volatility during high VIX periods, providing an advantage for option sellers and resulting in improved performance for their conditional strategies. Moreover, this conditional covered call strategy mirrors the CBOE S&P 500 Conditional BuyWrite Index (BXMC) introduced in August 2015, wherein the units of option writing are determined by the VIX level on the roll date.[4]

This study aims to propose an effective conditional strategy to enhance option writing strategies within the Taiwan market, which stands out as one of the few global markets developing tradable products for covered call strategies, and where retail investors play a predominant role.[5] We begin by assessing the effectiveness of conventional option writing strategies using TXO contracts,[6] including the buy-write (Whaley, 2002; Figelman, 2008; Israelov and Nielsen, 2014; 2015), put-write (Ungar and Moran, 2009; Natter, 2018; Patel et al., 2024), and their combined variant, the covered combo strategies (Natter, 2018, Liu and Chang, 2021). These strategies are passively managed, adhering to standard rules, and systematically selling options on roll dates. Specifically, the buy-write strategy involves writing call options against a long market index position, while the put-write strategy entails selling put options and maintaining a portfolio of risk-free assets. Despite the theoretical equivalence

[4] Specifically, the BXMC strategy involves selling one call when the VIX is at or above 20, but only half a call when the VIX falls below 20. In contrast, Malkiel et al. (2018) sell one call on the roll date when the VIX surpasses its historical median; otherwise, they fully invest in the S&P 500 portfolio. However, the BXM strategy consistently sells a call.

[5] The launch of the TAIEX Covered Call OTM 5% Total Return Index in December 2019, followed by the listing of the first covered call ETN in Taiwan in December 2022, underscores the growing importance of innovative strategic indices in the Taiwan derivatives market. In addition, the Taiwan Stock Exchange holds a prominent position in the Asia-Pacific region, ranking sixth in market capitalization as of April 2024, marking a significant 25.0% increase from April 2023. In contrast, the Hong Kong Exchange, which ranks fifth in Asia-Pacific region, listed its first covered call ETF in February 2024.

[6] The TXO contracts, introduced in 2001, are actively traded and stand as the most representative option contracts in the Taiwan derivatives market.

suggested by put-call parity, studies like Ungar and Moran (2009) demonstrate the outperformance of put-write strategies over buy-write strategies, echoing the findings of negative put returns by Jackwerth (2000) and Coval and Shumway (2001), as well as deviation from put-call parity (Cremers and Weinbaum, 2010). Nonetheless, this phenomenon remains insufficiently explored in the global options market outside the United States.[7]

Our conditional strategies utilize the put-call ratio (PCR) to determine when to initiate a short options position. According to Billingsley and Chance (1988), the PCR acts as a contrarian technical indicator, reflecting investor consensus and predicting short-term index movements. Specifically, when put volumes exceed call volumes, the subsequent day's S&P 100 index return tends to be significantly positive. Bandopadhyaya and Jones (2008) suggest that PCR is a superior sentiment measure compared to the VIX and is negatively related to the S&P 500 index return. Dennis and Mayhew (2002) point out that trading volume PCR may be noisier than open interest PCR, while Jena et al. (2019) find that open interest PCR is a more effective predictor of Nifty index return compared to volume PCR. Numerous studies support the informational content of PCR in predicting individual stock returns (Cao et al., 2005; Pan and Poteshman, 2006; Blau et al., 2014, 2016). These findings prompt the question of whether replacing the VIX-based conditional strategy of CBOE and Malkiel et al. (2018) with the PCR could yield comparable enhancements in the effectiveness of option writing strategies.

Chang et al. (2009) emphasize the crucial role of investor types in elucidating the predictive power of PCR. Utilizing a unique dataset spanning from 2001 to 2005, they

[7] Che and Fung (2011) and O'Connell and O'Grady (2014) indicate that the buy-write index offers higher returns but lower standard deviations in the Hong Kong and Australian markets, respectively. However, they do not explore the put-write strategy or address the deviations from put-call parity.

identify a negative correlation between the volume PCR of foreign institutional investors and the subsequent day's Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) return. Conversely, the volume PCR of individual investors exhibits a positive yet statistically insignificant correlation with the following day's TAIEX return. Given the dominance of retail investors in the Taiwanese derivatives markets, our conditional strategies involve full investment in TAIEX when PCR is high and implementation of the option writing only when PCR is low.

Our empirical findings highlight several key points. Firstly, the conditional strategies not only enhance the average returns of TAIEX but also mitigate the portfolio risk. The Sharpe (Sortino) ratios increase from 0.58 (0.90) to 0.71 (1.03), 0.86 (1.29), 0.79 (1.14), and 0.78 (1.12) for the conditional buy-write, conditional put-write, conditional covered combo, and conditional delta-hedged strategies, respectively. Moreover, the maximum drawdown of conditional strategies decreases, and the CAPM alpha improves. Although previous studies link buy-write returns to the variance risk premium (Figelman, 2008; Israelov and Nielsen, 2015; Malkiel et al., 2018), we focus more on the unfavorable scenarios where the buy-write underperforms the market index. Our empirical results support the effectiveness of the PCR in avoiding selling options during bullish periods and significantly improving strategy performance.

Secondly, conventional option writing strategies, without incorporating the PCR conditions, carry less risk but might not beat the market index. The Sharpe (Sortino) ratios for the unconditional buy-write, put-write, covered combo, and delta-hedged strategies are 0.48 (0.71), 0.55 (0.87), 0.58 (0.84), and 0.15 (0.29), respectively. While these findings align with Malkiel et al. (2018), they differ from studies in the Hong Kong market by Che and Fung (2011) and the Australian market by O'Connell and O'Grady (2014). This underperformance emphasizes that option writing strategies may not always work globally, reinforcing the need for our conditional approach. Not only does it enhance portfolio returns, but it also significantly reduces trade frequency. Over the 201-month period from March 2007 to December 2023, our conditional strategies initiate option writing for only 68 to 109 months, thereby cutting transaction costs compared to conventional strategies, making it more practical in real-world applications.

Thirdly, in terms of real-world application, we assess the trading performance by substituting the investment in TAIEX with holding TAIEX futures, rolling each month, for two main reasons. Firstly, while the TAIEX consists of approximately 1,000 stocks, the 100 largest stocks make up about 80% of its value, making direct trading of TAIEX constituents costly due to numerous small and illiquid stocks.[8] Secondly, there is a crucial 15-minute difference between the closing times of the Taiwan stock market (13:30 pm) and the Taiwan derivatives market (13:45 pm). This discrepancy poses challenges when using the closing price of the TAIEX index with the settlement price of option contracts, leading to issues of non-synchronicity. However, replacing TAIEX with its futures in the option writing strategies does not alter our conclusion that the PCR conditional approach consistently outperforms the benchmark index with higher returns but lower risk. Moreover, the difference between buy-write and put-write strategies (or between conditional buy-write and conditional put-write) narrows significantly, indicating that the superior performance of the put-write strategy over the buy-write strategy may stem from market inefficiencies, nonsynchronous prices (Battalio and Schultz, 2006), or short-sale constraints (Ofek et al., 2004) of the underlying index. These findings underscore the practical viability of using TAIEX futures and highlight the effectiveness of PCR conditional strategies.

[8] Despite the existence of ETFs tracking the top 50 stocks in Taiwan, their option contracts are less liquid and were introduced only as recently as December 2015.

Fourthly, comparing our PCR-based approach with VIX-based conditional strategies of CBOE and Malkiel et al. (2018), as well as alternative signals, we observe that PCR provides superior guidance for option writing decisions, suggesting that using open interest PCR is more effective than the TAIEX Options Volatility Index (VIXTWN), variance risk premium (VRP), jump risk premium (JRP), and volatility jump (VJ) factors for improving option writing strategies. Upon analyzing the relationships between PCR, VIXTWN, and future TAIEX returns, we observe negative associations between PCR measures and VIXTWN. However, VIXTWN's predictability in identifying future TAIEX returns is less pronounced than that of PCR measures. Additionally, the current VIXTWN level demonstrates predictability in forecasting future VIXTWN changes, aligning with volatility's mean-reverting nature. However, there is no clear relationship between PCR measures and future VIXTWN changes. These findings underscore PCR's effectiveness in enhancing option writing returns due to its return predictability, while VIXTWN is better suited for predicting future volatility changes. Fundamentally, utilizing PCR as a condition to enhance option writing returns differs from the implied volatility approach. In summary, avoiding selling call options during rallies is more critical for improving option writing strategies than profiting from changes in implied volatility.

Finally, we examine the option writing performance using institutional investors' position. Consistent with Chang et al. (2009), our analysis shows that the open interest PCR for foreign institutional investors is negatively related to the subsequent month's TAIEX return. However, this relationship is less pronounced and does not affect the significance of the market-aggregated PCR. Regarding the risk-return profiles of these conditional strategies, we find that using institutional investors' positions may still outperform the market and generate portfolios with low risk and high return.

Nevertheless. it is generally less effective than utilizing the publicly available market-aggregated PCR.

The remainder of this paper is organized as follows. Section 2 introduces the data, the constructions of conventional option writing strategies, the definitions of PCR, and the proposed conditional strategies. Section 3 presents empirical results, including risk and performance measures, cumulative returns, and detailed discussions. Section 4 expands on the robustness checks, and Section 5 concludes the study with key findings and implications.

2. Data and Methodology

2.1 Data

The TXO is a European-style option with the underlying being the TAIEX and stands as the most representative contract in the Taiwan derivatives market. Data for TXO used in this study was obtained from the Taiwan Economic Journal (TEJ) database, covering daily variables such as OHLC prices, settlement price, last bid, last ask, open interest, volume, underlying price and return, historical and implied volatilities, time to maturity, strike price, and option Greeks. The 1-month Taiwan Time Deposit Rate was employed as a proxy for the risk-free rate. To account for transaction costs, we extracted the historical TAIFEX-required margin amounts from the TEJ database. To control the futures position, daily open interest data for TAIEX futures was also extracted from the TEJ database. Furthermore, the VIXTWN, compiled according to the CBOE VIX methodology, was downloaded from the Taiwan Futures Exchange, and high-frequency intraday TAIEX data for calculating realized volatility was sourced from the Taiwan Stock Exchange.

The data period spans from March 2007 to December 2023. This timeframe was chosen to ensure adequate open interest levels and to establish reliable option writing conditions, excluding the first five years of options data due to the low open interest levels at the early stage of TXO introduction. Additionally, the VIX-based conditional strategy requires historical observations of at least three months, and the VIXTWN was launched by the Taiwan Futures Exchange on December 18, 2006. The descriptive statistics of TXO over our sample period are presented in the Appendix.[9]

In addition to obtaining daily open interest and volume data for all market participants, we accessed a dataset covering institutional investors' positions from the Taiwan Futures Exchange for the period from April 2008 to December 2023. This dataset provides detailed insights into the daily open interest and volume for both foreign and domestic institutional investors, distinguishing between buy and sell positions for call and put options.

Figure 1 depicts the average daily open interest (upper figure) and trading volume (lower figure) percentages among various investor types in the TXO contracts, clearly highlighting the dominance of individual investors. Notably, individual investors consistently account for over 50% of open interest throughout most periods, while foreign and domestic institutional investors collectively contribute between 20% and 30%. In terms of trading volume, both individual investors and domestic institutional investors emerge as the primary participants, with a slight decrease in trading volume by individual investors until after 2022. These observations may have implications for other derivatives markets, particularly in light of the recent surge in retail trading in the U.S. market, as documented by Bryzgalova et al. (2023).

<Figure 1 is inserted about here>

Figure 2 illustrates the average daily TXO open interest for foreign (top figure) and domestic (second figure) institutional investors' positions for each month from

[9] We are grateful to an anonymous reviewer for suggesting that we re-examine our sample for the potential look-ahead bias as discussed in Duarte et al. (2023) and Duarte et al. (2024).

April 2008 to December 2023. Foreign institutional investors predominantly hold buy positions in the options market, while domestic institutional investors maintain slightly higher sell positions than buy positions. In addition, both figures show that institutional investors tend to buy put options, indicating their hedging demand.

<Figure 2 is inserted about here>

To discern institutional investors' perspectives regarding market directions, we classify buy call and sell put positions as bullish and buy put and sell call positions as bearish. The third and bottom figures in Figure 2 depict these bullish and bearish positions for foreign and domestic institutional investors, respectively. Notably, institutional investors exhibit distinct viewpoints at the end of 2017, with foreign institutional investors being bearish and domestic institutional investors being bullish. In other periods, the differences between institutional investors' bullish and bearish positions are insignificant.

2.2 Option Writing Strategies

This section introduces various option writing strategies employed in this study. We consider three main strategies: buy-write, put-write, and their combined variant, the covered combo strategies. The buy-write strategy, discussed in prior works by Whaley (2002), Figelman (2008), and Israelov and Nielsen (2014; 2015), involves writing call options against a long position on TAIEX. The put-write strategy, explored by Ungar and Moran (2009), Natter (2018), and Patel et al. (2024), entails selling put options and maintaining a portfolio of risk-free assets. Lastly, we introduce the covered combo strategies, as discussed by Natter (2018) and Liu and Chang (2021), which combine elements of both buy-write and put-write strategies with different strike prices.

Figure 3 displays the payoff functions for option writing strategies using the transaction data on November 20, 2019. The left figure illustrates the payoff functions for at-the-money (ATM) buy-write and put-write strategies, with a TAIEX level of 11,631 and strike prices of 11,600 for the put option and 11,700 for the call option. Although these two strategies are theoretically equivalent, the practical challenge arises when perfect ATM strike prices are unavailable, leading to the selection of out-of-the-money (OTM) contracts closest to the spot TAIEX. This selection results in different strike prices and performance for the two strategies. Notably, both strategies underperform the TAIEX only when the index experiences a significant increase, indicating that avoiding option writing during bullish periods can enhance these strategies.

<Figure 3 is inserted about here>

The right figure of Figure 3 depicts the payoff functions for an ATM buy-write strategy and a covered combo strategy, with strike prices of 11,600 for the ATM put option and 11,900 for the 2% OTM call option. While the covered combo strategy generates higher income than the buy-write strategy, it also carries greater downside risk relative to TAIEX.

The calculation of the buy-write index (BXM_t) follows the methodology established by the CBOE, beginning on the first day of strategy execution, with the initial index BXM_0 set to 100. At the close of each trading day, the index is updated and computed using the following formula:

$$BXM_t = BXM_{t-1} \times \frac{S_t - C_t}{S_{t-1} - C_{t-1}}, \tag{1}$$

where S_t represents the TAIEX Total Return Index (including cash dividends) at day t, and C_t represents the price for the selected call option at day t. This index is constructed using a monthly roll, selling the nearby ATM call option on the expiration date, typically the third Wednesday of each month. For instance, we start holding the TAIEX on March 21, 2007, and sell an ATM call option that expires on April 18, 2007, with the purchase cost being the closing price on March 21, 2007.

Similarly, the calculation of the put-write index (PUT_t) follows the methodology established by the CBOE. At the close of each trading day, the index is updated and computed using the following formula:

$$PUT_t = PUT_{t-1} \times \frac{M_t - P_t}{M_{t-1} - P_{t-1}}, \tag{2}$$

where PUT_0 is set to 100, P_t represents the price for the selected put option at day t, and M_t represents the balance of the money market account at day t, which is the present value of the strike price K:

$$M_t = K \times e^{-r\tau/365}, \tag{3}$$

where r is the risk-free rate and τ is the days to maturity at time t. Next, the calculation of the covered combo index ($CMBO_t$) follows the methodology established by the CBOE, utilizing the following formula:

$$CMBO_t = CMBO_{t-1} \times \frac{S_t + M_t - Q_t - P_t}{S_{t-1} + M_{t-1} - Q_{t-1} - P_{t-1}}, \tag{4}$$

where $CMBO_0$ is set to 100, and Q_t represents the price for the selected OTM call option at day t.

Finally, the calculation of the delta-hedged index (DH_t) is defined as:

$$DH_t = DH_{t-1} \times \frac{S_t - C_t/\Delta_{t-1}}{S_{t-1} - C_{t-1}/\Delta_{t-1}}, \tag{5}$$

where DH_0 is set to 100, and Δ_{t-1} represents the Black-Scholes delta of the corresponding call option at day $t-1$. We express the delta-hedged option portfolio as $S_t - C_t/\Delta_{t-1}$ rather than $\Delta_{t-1}S_t - C_t$ (Zhan et al., 2022; Duarte et al., 2023) because our study focuses on strategies directly comparable to passive stock index investments, where the underlying asset is held with unit consistency.

2.3 Put-Call Ratio (PCR)

We define the PCR following methodologies established by Pan and Poteshman (2006), Chang et al. (2009), and Blau et al.(2014). This metric is calculated as the ratio of open interest (or volume) in put options to the total open interest (or volume) at a given time:

$$OIPCR_t = \frac{OI_t^{put}}{OI_t^{put} + OI_t^{call}}, \tag{6}$$

$$VOLPCR_t = \frac{VOL_t^{put}}{VOL_t^{put} + VOL_t^{call}}, \tag{7}$$

where OI_t^{put} and OI_t^{call} represent the total open interest for put options and call options at time t, while VOL_t^{put} and VOL_t^{call} represent the total volume for put options and call options at time t. The PCR benchmark is 0.5; a value above 0.5 indicates a preference among market participants for holding or trading put options over call options.

Figure 4 depicts the time series of various moving medians of TXO's PCR over the sample period, designed to mitigate noisy variations. The open interest PCR typically fluctuates between 0.3 to 0.7 across most periods but plunges to extremely low levels during the 2009 financial crisis, prompting a robustness check to exclude this crisis period. In contrast, volume PCR exhibits lower volatility compared to open interest PCR; nevertheless, both PCR definitions exhibit similar patterns over time. Consistent with Chang et al. (2009), PCR demonstrates a positive correlation with the TAIEX, regardless of whether it is constructed using open interest or trading volume, with correlation coefficients of 0.167 and 0.187, respectively.

<Figure 4 is inserted about here>

2.4 Conditional Option Writing Strategies

Following the VIX-based conditional strategy of CBOE and Malkiel et al. (2018), we develop a conditional option writing strategy that alternates monthly between two passive investment strategies: the market index and the option writing index (buy-write, put-write, or covered combo). The key difference lies in the focus of the strategies. The VIX-based conditional strategy aims to exploit periods of high implied volatility to execute buy-write strategies, capitalizing on the overpricing of options. In contrast, our strategy seeks to avoid selling options during times of significant market index increases, as option writing strategies tend to underperform in such scenarios. Based on our analyses in Section 2.3, our conditional strategies involve full investment in TAIEX when PCR is high and implementing option writing only when PCR is low.

Specifically, our conditional strategy follows a simple rule: allocate full investment to TAIEX if the open interest PCR measure on the formation date exceeds 0.5 and initiate option writing if the open interest PCR measure falls below 0.5. Recognizing the rigidity and limitations of a fixed threshold, we also introduce a dynamic condition: fully invest in TAIEX if the 20-day moving median of the open interest PCR exceeds its 60-day moving median on the formation date, and engage in option writing if it falls below this median. Results employing alternative moving median periods or volume PCR measures are addressed in the robustness checks.

Although the TAIEX itself is not directly tradable, this limitation can be addressed by trading TAIEX futures, which are highly correlated with the TAIEX and converge to its level at expiration. In addition, the Taiwan stock market closes at 13:30, while the Taiwan derivatives market closes at 13:45, posing a data non-synchronicity issue. Therefore, we conduct an alternative analysis that replaces the TAIEX with its nearby futures contract price when calculating the market index returns and option writing indices, enhancing the practical viability of our strategy. For the sake of fair comparison, we do not consider the high leverage characteristics of futures trading with margin accounts. Instead, we assume operating index futures with full margin, treating it as a prepaid forward contract, rendering the issue of margin calls negligible.

2.5 Alternative Signals

In addition to the publicly available sentiment measures PCR and VIX from the exchange, we construct three option-related variables commonly discussed in the literature as alternative signals.

First, we measure the VRP following Bollerslev et al. (2009) and Hu and Liu (2022). The VRP is defined as the difference between realized volatility (RV) and the VIX index:

$$VRP_t = RV_{t-30,t} - VIX_t, \tag{8}$$

where $RV_{t-30,t}$ represents realized volatility, calculated using 5-minute index returns over the past 30 days.[10] In our alternative conditional strategies, we fully invest in the TAIEX when VRP is high and implement option writing only when VRP is low.

Second, following Hu and Liu (2022), we define the JRP as the difference in average implied volatilities (IV) between OTM and ATM put index options:

$$\mathrm{JRP}_t = IV_t^{OTM} - IV_t^{ATM}, \tag{9}$$

where OTM and ATM put options correspond to strike-to-spot price ratios (K/S) within the ranges $[0.9, 0.94]$ and $[0.98, 1.02]$, respectively. To ensure adequate liquidity, the sample is restricted to options with maturities between 25 and 33 calendar days. We implement option writing only when JRP is high.

[10] Monthly realized volatility for the TAIEX is computed by summing 55 within-day 5-minute squared returns during regular trading hours (09:00 to 13:30), along with the overnight close-to-open return. For example, the realized volatility on a Wednesday includes the squared return from Tuesday 13:30 to Wednesday 09:00, followed by 54 squared 5-minute returns on Wednesday, from 09:00 to 09:05 through 13:25 to 13:30. The standard deviation of 5-minute returns over the past 30 days is then multiplied by the square root of 252×55 to annualize the realized volatility.

Finally, we calculate the VJ factor based on the methodology of Constantinides et al. (2013). This measure is defined as the sum of all daily increases in the average implied volatility of ATM call options exceeding 4%, or zero if no such increase occurs. ATM call options are defined as those with K/S within the range $[0.98, 1.02]$. The monthly volatility is calculated as the difference between the average implied volatility of ATM call options on the third Wednesday of the current month and the average implied volatility on the third Thursday of the previous month. Our alternative conditional strategy holds the passive stock index investment and implements option writing only when VJ is positive.

3. Empirical Results

The empirical results are organized as follows. Section 3.1 presents the risk and return profiles of the market index, conventional option writing strategies, and our conditional option writing strategies. In Section 3.2, we analyze the impact of transaction costs. In Section 3.3, considering tradability and data synchronicity issues, we present the results using the TAIEX nearby futures price instead of the TAIEX index. Section 3.4 compares our PCR approach with the VIX approach of CBOE and Malkiel et al. (2018) and alternative signals. Finally, Section 3.5 investigates whether institutional investors' buy and sell positions improve option writing strategies more effectively than the market-aggregated PCR.

3.1 Performance of Option Writing Strategies

Table 1 presents the risk and performance metrics for the TAIEX and various option writing strategies over the period from March 21, 2007 to December 20, 2023. These measures are annualized and calculated using daily index data, employing the PerformanceAnalytics package in R. The risk measures include the standard deviation, lower partial standard deviation (LPSD), and maximum drawdown (MDD). The performance measures encompass the Sharpe ratio, Sortino ratio, and the CAPM alpha, obtained through time-series regression of portfolio returns on TAIEX returns. Additionally, our untabulated results indicate the number of writing months for the option writing strategies out of the total of 201 months. For these months, we calculate the Outperformance Ratio, which represents the proportion of months where the strategy's returns exceed those of the TAIEX.

<Table 1 is inserted about here>

Panel A of Table 1 shows that the annualized returns of TAIEX and the buy-write index (BXM) are 15.27% and 10.29%, respectively. Their standard deviations are 21.89% and 17.20%, LPSD are 15.79% and 12.93%, and MDD are 56.02% and 46.19%. As expected, BXM has a lower risk profile compared to TAIEX, with a CAPM beta of 0.74 (untabulated), significantly lower than one. However, despite the reduced risk, BXM's Sharpe ratio and Sortino ratio remain relatively low. This finding aligns with Malkiel et al. (2018) but contrasts with studies in the Hong Kong market by Che and Fung (2011) and the Australian market by O'Connell and O'Grady (2014), indicating that option writing strategies perform differently across markets. The BXM's outperformance ratio of 67.16% (untabulated) demonstrates its ability to outperform TAIEX in about two-thirds of the months. Nonetheless, the strategy's missed profits during significant market upswings highlight the need for a conditional approach to improve overall portfolio returns.

Regarding the put-write index (PUT) and the covered combo index (CMBO), their risk and return profiles fall between those of TAIEX and BXM. Both indices have higher Sharpe and Sortino ratios than BXM, but do not outperform the TAIEX. Consistent with Ungar and Moran (2009) and Malkiel et al. (2018), PUT outperforms

BXM, indicating a deviation from put-call parity (Cremers and Weinbaum, 2010) and potential option mispricing (Jackwerth, 2000; Coval and Shumway, 2001). However, the outperformance ratios for PUT and CMBO fall below 50% (untabulated), highlighting the subpar performance of conventional option writing strategies in Taiwan and reinforcing the need for enhancements in these strategies.

The delta-hedged index (DH) represents the least risky portfolio among all strategies, with a standard deviation of 15.72%, LPSD of 11.91%, and MDD of 43.67%. However, the annualized returns were substantially diminished by its hedged positions, resulting in extremely low Sharpe and Sortino ratios. These results further underscore the necessity of adopting a conditional approach to enhance portfolio returns.

The last four columns in Panel A of Table 1 show that all conditional option writing strategies provide higher annualized returns than TAIEX (15.27%), with values of 15.76%, 20.41%, 17.66%, and 16.39% for the conditional buy-write index (CBXM), conditional put-write index (CPUT), conditional covered combo index (CCMBO), and conditional delta-hedged index (CDH) respectively. The CAPM alphas are all significantly positive, with values of 2.46%, 7.35%, 4.11%, and 5.39%. Importantly, these conditional option writing strategies also exhibit lower risk measures, with the exception of CPUT, which has a slightly higher standard deviation than TAIEX. Consequently, the Sharpe and Sortino ratios significantly improve. The Sharpe ratios for conventional strategies are 0.48, 0.55, 0.58, and 0.15, while those for the corresponding conditional strategies are 0.71, 0.86, 0.79, and 0.78, respectively, compared to TAIEX's 0.58. Similar significant improvements are observed in the Sortino ratio and CAPM alpha. These results support the effectiveness of our conditional strategies. Equally important, these conditional strategies involve selling options for only 68 months out of 201 months, greatly reducing trade frequency and enhancing practical viability.

Figure 5 depicts the cumulative returns of CBXM (light blue dotted line), CPUT (light red dotted line), and CDH (light green dotted line) throughout our sample period, with an initial value of 100. The benchmarks are BXM (blue dashed line), PUT (red dashed line), DH (green dashed line), and TAIEX (gray solid line). For simplicity and to avoid cluttering the graph, we have excluded the lines for CMBO and CCMBO. The upper graph shows the conditional strategies that involve option writing only when the open interest PCR is less than 0.5. The lower graph depicts conditional strategies that involve option writing only when the 20-day moving median of open interest PCR is less than its 60-day moving median. Both figures clearly demonstrate the substantial improvements of conditional strategies over their unconditional counterparts. Notably, the conditional strategies also have the potential to outperform the TAIEX, particularly with the naïve fixed threshold approach depicted in the upper figure.

<Figure 5 is inserted about here>

3.2 Performance with Option Trading Costs

Since transaction costs in the options market are substantial and partly responsible for the unprofitability of certain option strategies unprofitability of certain option strategies, we examine their impact on the feasibility of option writing strategies. Following Goyal and Saretto (2009) and Zhan et al. (2022), we measure option trading costs using the bid-ask spread and margin requirements. First, we account for transaction costs by considering effective bid-ask spreads when buying and selling options. Panel B of Table 1 incorporates an effective spread equal to 50% of the quoted spread. For example, if the bid price of an option is \$10 and the ask price is \$11, we assume a purchase price of \$10.75 and a sale price of \$10.25.[11]

[11] Conversely, in Panel A of Table 1, transaction costs are not factored into the calculation of option writing strategy returns, as we assume options can be traded at the midpoint of the bid and ask price

Second, we investigate the opportunity costs of the margin requirements as our option writing strategies involve short option positions. We measure the margin cost as the borrowing cost to meet the margin requirement on each trading date. Consequently, the margin-adjusted option writing strategy return over $[t-1, t]$ is defined as

$$OWR_t = \frac{\mathrm{Index}_t - \mathrm{Index}_{t-1} - (r\Delta t)\cdot pM}{\mathrm{Index}_{t-1}}, \tag{10}$$

where Index_t represents various option writing indices defined in Equations (1), (2), (4), and (5), Δt is the time interval (e.g., 1/365), and p is the multiplier of the initial deposits relative to the TAIFEX-required margin amount M. In practice, brokers in Taiwan often recommend that investors deposit three times the required margin to lower the likelihood of margin calls. Therefore, we assume $p = 3$.

Panel B of Table 1 reveals that after accounting for transaction costs, the annualized returns, Sharpe ratios, and Sortino ratios of the BXM, PUT, CMBO, and DH strategies are slightly lower compared to those in Panel A, where transaction costs were not included. Notably, the decreases in annualized returns, Sharpe ratios, and Sortino ratios for the PCR-based conditional strategies are negligible, as these strategies generate only 68 hedging signals over the 201-month period, greatly reducing trade frequency. Despite these adjustments, the performance ranking of each strategy in terms of returns and risk remains consistent with Panel A, and the PCR-based conditional option writing strategies continue to outperform the market index (TAIEX). This indicates that transaction costs have a limited impact on the effectiveness of PCR in enabling option writing strategies to achieve high returns and low risk.

3.3 Option Writing Strategies Using Futures

quotes—implying an effective spread of 0% of the quoted spread.

To address the tradability of TAIEX and the data synchronicity issues between TAIEX and TXO, we conduct an alternative analysis by replacing TAIEX with its nearby futures contract price when calculating the market index returns and option writing indices. Consequently, the results presented in Section 3.1 are updated and shown in Table 2 and Figure 6.

<Table 2 is inserted about here>

<Figure 6 is inserted about here>

Panel A of Table 2 shows that the annualized return, standard deviation, and LPSD of TAIEX futures (TX) increased to 19.51%, 24.23%, and 17.24%, respectively. Consequently, the Sharpe ratio rises from 0.58 to 0.70, and the Sortino ratio significantly improves from 0.90 to 1.07. Except for the PUT and DH, the performance metrics of all option writing strategies are improved due to changes in the underlying value. However, the conclusions from Section 3.1 remain robust and even stronger. All conventional option writing strategies underperform TX in terms of Sharpe ratio and Sortino ratio, whereas all conditional option writing strategies significantly outperform TX. The Sharpe ratios of TX, CBXM, CPUT, CCMBO, and CDH are 0.70, 0.86, 0.89, 0.89, and 0.89 and their Sortino ratios are 1.07, 1.23, 1.34, 1.29, and 1.26 respectively. The CAPM alphas for CBXM, CPUT, CCMBO, and CDH are significantly positive, with values of 3.44%, 5.69%, 4.26%, and 7.54%, respectively, while the CAPM betas (untabulated) are significantly less than one, indicating low-risk and high-return profiles and the effectiveness of the proposed conditional strategies based on the PCR.

Figure 6 depicts the cumulative returns of option writing strategies using TX as the underlying. Consistent with the results in Figure 5, our conditional strategies consistently outperform TX when a fixed PCR condition is applied. Over the approximately 17-year period, the cumulative returns of CBXM, CPUT, and CDH exceed 700%, slightly higher than the benchmark TX. In contrast, the cumulative returns of BXM, PUT, and DH are less than 350%. This demonstrates that using the futures price instead of the TAIEX index enhances the overall performance but does not affect the effectiveness of these conditional strategies.

Interestingly, Figure 6 shows that the difference between BXM and PUT (or between CBXM and CPUT) narrows significantly, indicating that the superior performance of PUT over BXM observed in Section 3.1 may result from market inefficiencies or short-sale constraints of the underlying index. When market participants have a hedging demand to protect against downside risk, put option prices become more expensive, which benefits the put-write strategy and seems to be already priced into the futures price. These findings underscore the practical viability of using TAIEX futures, suggest TAIEX futures as an appropriate underlying for TXO, and support the effectiveness of PCR conditional strategies.

3.4 Comparisons with Alternative Signals

To assess the comparative efficacy of our PCR approach against the VIX-based conditional strategies of CBOE and Malkiel et al. (2018), we initially explore the relationships among PCR, VIXTWIN, and future TAIEX returns. In Table 3, we conduct a quartile analysis, organizing monthly data into quartiles based on key measures: open interest PCR in Panel A, volume PCR in Panel B, and VIXTWN in Panel C. We then examine the subsequent month's TAIEX, BXM, and DH returns, as well as the change in VIXTWN, aligning with Malkiel et al.'s (2018) discussions. Furthermore, we include mean differences between the fourth and first quartiles, with standardized test statistics provided in parentheses.

<Table 3 is inserted about here>

Panels A and B of Table 3 reveal intriguing and consistent observations. Firstly, there is no discernible relationship between the two PCR measurements. Sorting the data by open interest (volume) PCR fails to distinguish patterns in volume (open interest) PCR; the mean levels across quartiles remain relatively similar without showing monotonic trends. Secondly, both PCR measures demonstrate predictability in identifying future TAIEX returns. The mean returns for low PCR (Q1) are 0.02% and -0.51% in Panels A and B, respectively, while those for high PCR (Q4) are 1.81% and 1.92%, respectively. In particular, the differences sorted by volume PCR prove statistically significant, with mean returns exhibiting monotonic behavior among quartiles. Thirdly, both PCR measures display similar positive correlations with BXM returns. However, the differences in BXM returns between Q4 and Q1 are less pronounced compared to those in TAIEX returns. Lastly, both PCRs demonstrate negative associations with the current VXITWN, raising questions about whether PCR encapsulates comparable information from VIXTWN.

Panel C of Table 3 provides further insights into this question. When sorting the data by VIXTWN, both PCR measures also display monotonic patterns, aligning with the negative associations indicated in Panels A and B. However, the predictability of VIXTWN in identifying future TAIEX returns is less pronounced, if it exists at all. Regarding volatility forecasting, the current VIXTWN level demonstrates predictability in identifying future VIXTWN changes, consistent with the stylized fact of volatility's mean-reverting nature. Nevertheless, there is no clear relationship between PCR measures and future VIXTWN changes in Panels A and B of Table 3. These findings support our conjecture that PCR may offer more effective enhancements in the option writing strategy due to its return predictability, whereas VIXTWN is a better predictor of future volatility changes. Therefore, utilizing PCR as a condition to enhance option writing returns could be fundamentally different from the VIX approach of CBOE and Malkiel et al. (2018).

Table 4 presents the performance metrics for the TAIEX, unconditional option writing strategies (UOWS), and conditional option writing strategies based on PCR or alternative signals. The columns labeled VIX and VIX-m employ VIXTWN as the conditioning variable. The former strategy involves option writing only when the VIXTWN is above 20, as suggested by the CBOE, while the latter strategy follows an approach similar to Malkiel et al. (2018), implementing option writing only when the 20-day moving median of VIXTWN exceeds its 60-day moving median.

< Table 4 is inserted about here>

Table 4 reveals two noteworthy findings. Firstly, in line with Malkiel et al. (2018), the annualized returns, Sharpe ratio, and Sortino ratio of VIX-based CPUT outperform both the market index and the corresponding CBXM strategy. However, unlike Malkiel et al. (2018), who find that VIX-based CBXM strategies outperform the S&P 500 index, our results show that VIX-based CBXM strategies do not outperform the TAIEX in the Taiwan derivatives market. Secondly, aligning with the findings in Section 3.1, the annualized returns, Sharpe ratio, and Sortino ratio of PCR-based CPUT strategies surpass all other strategies, suggesting that using open interest PCR is more effective than VIXTWN for improving option writing performance. These results support our conjecture that avoiding selling options during market rallies using PCR is more straightforward and effective than targeting changes in implied volatility.

In the final three columns of Table 4, we extend our analysis to conditional option writing strategies based on VRP, JRP, and VJ, as defined in Section 2.5. For VRP-based strategies, there are 103 hedging signals over the 201-month period, and the performance closely mirrors that of the corresponding unconditional strategy. This suggests that while VRP may help reduce trading frequency and associated costs, it does not significantly improve trading performance. In contrast, JRP- and VJ-based strategies yield mixed results: some outperform the TAIEX and UOWS, while others underperform them. Overall, while strategies based on VRP, JRP, and VJ may occasionally outperform the index portfolio or UOWS, they do not achieve superior performance compared to strategies using publicly available sentiment measures such as PCR or VIX.

3.5 Institutional Investors' Position

In this section, we investigate whether institutional investors' positions provide a more reliable guide for option writing strategies. Table 5 presents the performance of conditional option writing strategies using PCR calculated based on institutional investors' positions rather than market-aggregated positions. Panels A and B show the results for foreign and domestic institutional investors, respectively, with each panel further distinguishing between PCRs calculated using buy or sell positions. Specifically, the PCR is calculated as the ratio of open interest in buy put positions to the total open interest in buy positions, with a similar definition applied to sell positions.

<Table 5 is inserted about here>

Compared to our main results in Table 1, Table 5 indicates that conditional strategies based on institutional investors' positions still outperform the TAIEX in terms of Sharpe and Sortino ratios, albeit marginally. The Sharpe (Sortino) ratios range from 0.53 to 0.62 (0.83 to 0.98) for foreign institutional investors and from 0.53 to 0.70 (0.80 to 1.10) for domestic institutional investors, with the TAIEX benchmarked at 0.56 (0.87). In contrast, the Sharpe (Sortino) ratios for market-aggregated PCR strategies in Table 1 range from 0.71 to 0.86 (1.03 to 1.29). This suggests that while using institutional investors' positions may outperform the market, it is generally less effective than utilizing publicly available market-aggregated PCR data.

The best PCR strategy in Table 5 is in scenarios using domestic institutional investors' sell position, where the annualized returns for CPUT and CCMBO are 16.68% and 14.95%, respectively, compared to the TAIEX benchmark of 14.37%. Correspondingly, the standard deviations are 21.10% and 19.57%, with the TAIEX benchmark at 21.29%. These results indicate that PCR conditional strategies can still be utilized to generate portfolios with low risk and high return.

To further explore the relationship between PCR and future TAIEX and delta-hedged returns, we estimate the following time-series regression model to assess the impact of PCR-related variables on returns for the subsequent expiration date (Ret_{t+1}):

$$Ret_{t+1} = \alpha + \boldsymbol{\beta X_t} + \boldsymbol{\gamma Z_t} + \epsilon_{t+1}, \tag{11}$$

where $\boldsymbol{X_t}$ represents the PCR-related variables, while $\boldsymbol{Z_t}$ includes control variables such as the TAIEX log-return over the previous month (Ret_t), the logarithm of the TAIEX futures' open interest ($\ln OITX_t$), historical volatility over the past 252 days (HV_t), VRP_t, $JUMP_t$, and VJ_t. In addition, we include institutional investors' positions as extra controls to investigate how investor type influences PCR's predictive power, as suggested by Chang et al. (2009). The correlation coefficients among these variables are presented in the Appendix.

The main regression results are presented in Table 6, showing the impact of PCR-related variables on subsequent TAIEX log returns (Panel A) and delta-hedged returns (Panel B). The first column (Aggregated) of Panel A shows that the market-aggregated PCR coefficients are statistically significant and positive, with this relationship holding after controlling volatility and jump risks, consistent with Billingsley and Chance (1988).[12] To investigate how the investor type influences PCR's predictive power, we

[12] We also examine the regression results when including only one of the PCR-related variables at a time. Our unreported results show that the open interest PCR offers a higher adjusted R-squared than the

include institutional investors' positions as extra controls. The columns labeled FI-Buy (DI-Buy) and FI-Sell (DI-Sell) indicate the PCRs calculated from the buy and sell positions of foreign (domestic) institutional investors, using both open interest and volume ratios. [13] Notably, incorporating PCR-related variables derived from institutional portfolios significantly improves the adjusted R-squared of Aggregated PCR models, highlighting their enhanced explanatory power.

<Table 6 is inserted about here>

In the FI-Buy column of Table 6, the open interest PCR for foreign institutional investors' buy position (Ins-OIPCR) is insignificantly negative (-0.0443), much smaller than the corresponding open interest PCR for all investors (0.3703). Therefore, the impact of the foreign institutional investors' buy position PCR on improving the performance of option writing strategies is not straightforward. On the other hand, the volume PCR for foreign institutional investors' buy position (Ins-VOLPCR) is significantly positive and provides greater explanatory power than the aggregate volume PCR (VOLPCR). However, because volume PCR may reflect either open or close positions, it can produce conflicting predictions about future returns, thus making this variable noisier.

The impact of domestic institutional investors' position on future TAIEX returns is less pronounced. In the DI-Sell column of Panel A, the open interest PCR for domestic institutional investors' sell position (Ins-OIPCR) is insignificant, with a coefficient of 0.0429 and a *t*-statistic of 0.612. While the volume PCR for domestic institutional investors' sell position (Ins-VOLPCR) is significantly negative, the

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volume PCR, echoing the findings of Dennis and Mayhew (2002) and Jena et al. (2019). These results yield lower adjusted R-squared values but maintain similar levels of significance for the coefficients.

[13] We also calculate a bearish-bullish ratio to gauge institutional investors' market outlook, defined as the ratio of total bearish positions (i.e., buy put and sell call) to total positions. However, the results are similar to buy position PCR.

coefficient of -0.4828 is smaller than the volume PCR among all investors, which has a value of 0.6747. Moreover, across all columns in Panel A, the VRP coefficients are negative and significant, consistent with Bollerslev et al. (2009), who show that the difference between implied and realized variation accounts for time-series variations in aggregate stock market returns. These findings also support the results in Table 4, indicating that VRP-based option writing strategies can enhance the performance of unconditional option writing strategies.

Although the positive predictability of the market-aggregated PCR for future TAIEX returns might suggest contrarian behavior by individual investors (Billingsley and Chance, 1988)—especially in a market dominated by retail investors like the TXO—another potential explanation for the positive relationship between PCR and future index return is the financial burden of overnight risk and margin obligations, which falls on the option seller rather than the buyer. From the seller's perspective, a high open interest PCR suggests a prevalence of short put positions over short call positions, indicating a bullish sentiment toward future TAIEX returns. However, identifying the exact reason for this relationship is beyond the scope of this study.

In Panel B of Table 6, we use delta-hedged returns as the dependent variable in our time-series regression and present the corresponding results. Given that the delta-hedging strategy is neutral and less sensitive to movements in the underlying prices, we expect that factors influencing its returns are related to volatility measures or higher moments. Consistent with this expectation, the first column (Aggregated) of Panel B shows that the coefficient of aggregated open interest PCR (OIPCR) is statistically insignificant. However, when controlling for PCRs calculated from the buy and sell positions of foreign or institutional investors, we observe a significant positive relationship between PCR and future delta-hedged returns. This underscores the importance of jointly considering multiple investor types when predicting future delta-hedged returns. Moreover, across all columns in Panel B, VJ emerges as a robust and positive predictor. These findings partially resemble the results of Constantinides et al. (2013), who attribute option return predictability to crisis-related and volatility factors.

Overall, these findings highlight the nuanced interplay between investor-driven option positions and standard volatility-related factors in forecasting future option strategy returns. Table 6 further shows that including institutional investors' positions, as well as variance and jump risk factors, does not fundamentally alter the direction or the predictive power of the market-aggregated PCR.

4. Robustness Checks

This section conducts robustness checks to validate our empirical findings. Section 4.1 tests whether excluding well-known market downtrends, such as the subprime crisis and the COVID-19 pandemic, affects our results. Section 4.2 explores the impact of increasing the rebalancing frequency of the option writing strategies from monthly to weekly and daily intervals. In Section 4.3, we examine the performance of the strategies when using OTM options to assess the effect of option moneyness. Finally, Section 4.4 evaluates the robustness of our results under alternative definitions of the PCR conditions by considering various combinations of short-term and long-term PCR measures.

4.1 Market Downtrends

Given that the option writing strategy is expected to outperform the underlying index during market downtrends, including periods like the financial crisis might artificially enhance our results. Therefore, our first robustness check excludes well-known downtrend periods, such as the subprime crisis and the COVID-19 pandemic's impact on the stock market. Specifically, we exclude all trading dates where TAIEX decreased more than 20% compared to its previous 50-day level, primarily focusing on the periods from July 2008 to December 2008 and March 2020. Consequently, we reexamine the alpha and beta via time-series regressions of portfolio returns on the TAIEX or TX returns with a dummy variable indicating these periods, as presented in Table 7, to determine whether the results remain robust without the influence of these downtrend periods.

<Table 7 is inserted about here>

In Table 7, all the alphas for the conditional strategies decrease and become less significant, which is consistent with our expectations. However, the alphas of CPUT and CCMBO in Panel A, as well as the alphas of CBXM and CCMBO in Panel B, remain significantly positive. On the other hand, all the betas stay significantly less than one, indicating that these conditional option writing strategies may still generate low-risk and high-return performance even in the absence of substantial market downtrends.

4.2 Rebalance Frequency

Our earlier analysis focused on the performance of option writing strategies with monthly rebalancing, aligning with the approach of the CBOE option strategy index and practical covered call ETFs. However, Chang et al. (2009) highlight that indicators related to option trading volume contain short-term predictive informational content about future movements in underlying prices. This suggests that increasing the rebalancing frequency may enhance the performance of option writing strategies by capturing these short-term signals more effectively.

Frequently rebalancing, however, also incurs higher transaction costs, potentially offsetting the gains from improved informational efficiency. Goyal and Saretto (2009) emphasize that transaction costs can substantially erode profits, which is why their delta-hedged portfolio is held until expiration to minimize the impact of the bid-ask spread. This trade-off introduces opposing forces: leveraging short-term predictive information versus mitigating transaction costs, both of which influence overall strategy performance.

To explore this trade-off, we modified the original strategy, which rebalanced positions monthly (established on the third Wednesday and held until the next month's expiration), by implementing weekly and daily rebalancing schedules. Tables 8 and 9 present the performance metrics for these higher-frequency strategies.

<Table 8 is inserted about here>

<Table 9 is inserted about here>

The results in Tables 8 and 9 reveal that increasing the rebalancing frequency can enhance trading performance when transaction costs are excluded. For instance, the Sharpe ratios for the BXM strategy rise to 0.66 with weekly rebalancing and 0.69 with daily rebalancing, both exceeding the TAIEX's Sharpe ratio of 0.58. However, after accounting for transaction costs, the Sharpe ratios decrease to 0.62 for weekly rebalancing and 0.56 for daily rebalancing. These findings suggest that while weekly rebalancing offers the potential for further performance improvement, the benefits of daily rebalancing are largely offset by the impact of transaction costs.

An important advantage of the conditional strategy is its ability to reduce the number of trades while sustaining superior performance. In line with the monthly rebalancing results presented in Table 1, the conditional strategy in Tables 8 and 9 continues to outperform the index portfolio under both weekly and daily rebalancing scenarios. These findings underscore the practical value of conditional strategies, which effectively balance the advantages of predictive information with the costs of frequent trading, achieving the desired investment objectives of high returns and low risk.

4.3 Moneyness

We further investigate whether the performance of option writing strategies varies with the moneyness of the option contracts (Kapadia and Szado, 2007; Che and Fung, 2011; Liu and Chang, 2021). Since OTM options are more liquid than in-the-money (ITM) options, we conduct robustness checks using option writing strategies constructed with 2% and 4% OTM option contracts, as shown in Panels A and B of Table 10, respectively.

<Table 10 is inserted about here>

The results in Table 10 reveal that, although the performance metrics of each strategy differ slightly from previous results, the ranking of the conditional option writing strategies in terms of returns and risks remains largely consistent with those based on near ATM options. These conditional strategies continue to deliver significantly better performance than conventional option writing approaches. Compared to the market index, they offer lower risk, higher returns, and significantly positive alpha values, demonstrating their robustness across different moneyness levels.

4.4 Alternative Moving Windows of PCR

Finally, we examine the results for alternative dynamic conditions of PCR, as mentioned in Section 2.4. Specifically, we fully invest in TAIEX if the short-term open interest PCR measure exceeds its long-term counterpart on the formation date; otherwise, we engage in option writing. The short-term and long-term PCRs are defined as the medians for the past x and y days, respectively. Table 11 presents the results for various (x,y) combinations, including (20,60), as in the main results in Table 1, and (1,60), (5,60), (5,240), (20,240), and (60,240) for robustness checks. For each panel, the results for BXM, PUT, and CMBO are presented in the column labeled UOWS, which refers to unconditional option writing strategies. Consequently, the results are quantitatively and qualitatively similar; conditional strategies consistently outperform both the TAIEX and UOWS, regardless of the PCR definition. These findings reinforce the effectiveness of using PCR conditions to enhance option writing strategies.

<Table 11 is inserted about here>

5. Conclusion

This study presents five significant findings and contributions. Firstly, we introduce an easily implemented strategy that alternates between the market index and the option writing index, both well-established passive investment strategies based on the PCR. This approach helps avoid the common underperformance of option writing during market rallies. Our results show that this strategy significantly enhances index returns while mitigating risk in the Taiwan market, leading to higher Sharpe and Sortino ratios, reduced maximum drawdown, and improved CAPM alphas. Secondly, compared to conventional option writing strategies, our approach not only improves performance metrics but also greatly reduces trade frequency, making it more practical. Thirdly, using prepaid TAIEX futures instead of direct TAIEX investments underscores the strategy's real-world viability and narrows deviation from put-write and buy-write strategies. Fourthly, our comparisons with the VIX-based conditional strategy of CBOE and Malkiel et al. (2018), as well as alternative signals, show that PCR offers superior guidance for option writing, leading to better predictability of future index returns and overall strategy performance. These findings indicate that avoiding option writing during market upswings, as indicated by PCR, is more effective than leveraging changes in implied volatility. Finally, we find that while using institutional investors' positions may still outperform the market and generate portfolios with low risk and high return, it is generally less effective than utilizing the publicly available market-aggregated PCR.

In summary, this study provides a robust framework for constructing low-risk, high-return portfolios through option writing, offering valuable insights for both options trading and portfolio management. Despite the Taiwanese derivatives market not being particularly large, it stands out as one of the few global markets developing tradable products for covered call strategies. Moreover, the predominance of retail investors makes sentiment measures more indicative and informative. Given the growing dominance of retail trading in the U.S. options market (Bryzgalova et al., 2023), our findings from a retail investor-dominated market provide valuable insights and may stimulate the development of new financial products by investment funds or the launch of new strategic indexes by entities like the CBOE.

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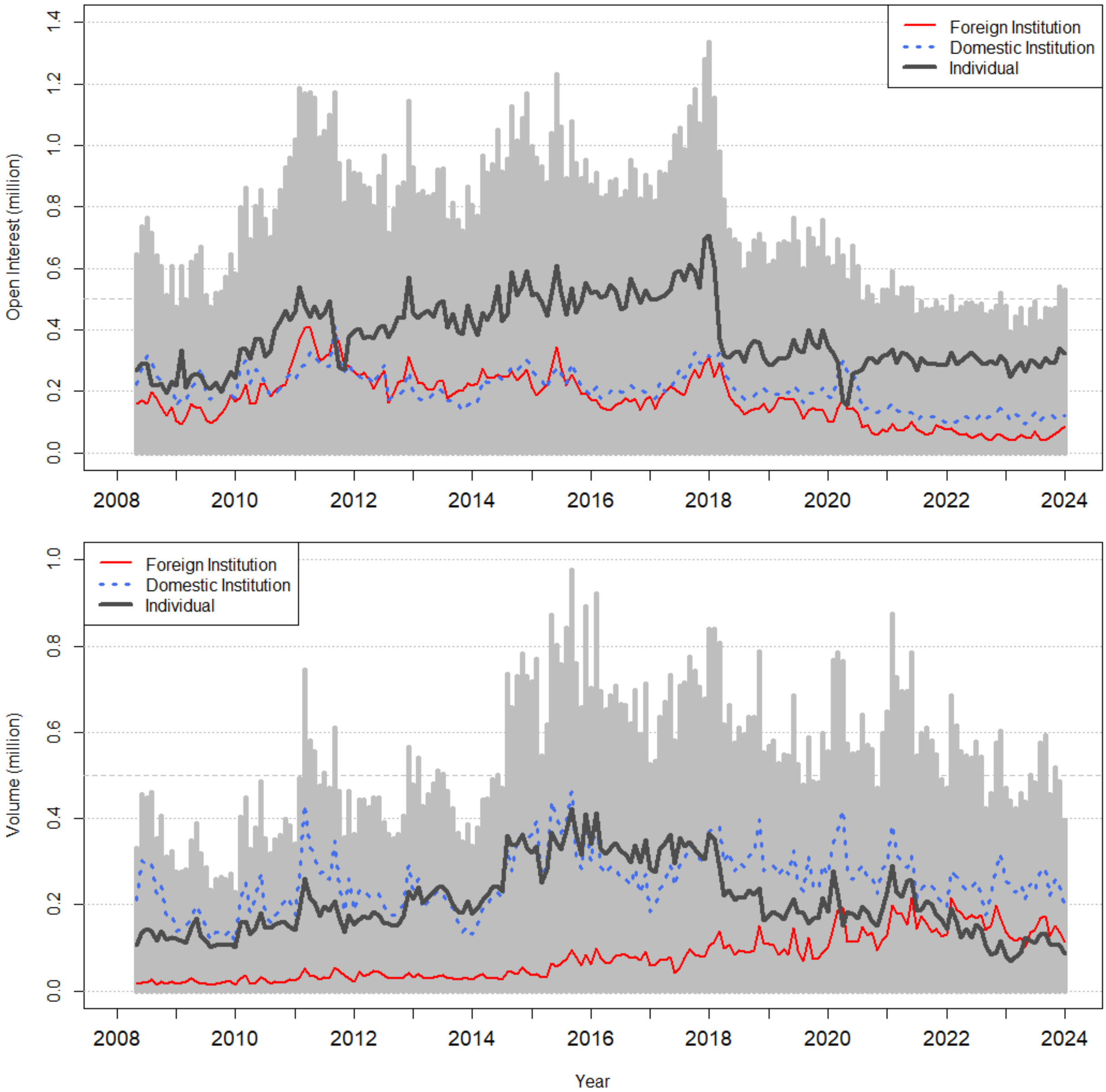

Figure 1. Trading Activities of TAIEX Options

This figure illustrates the average daily open interest (upper figure) and trading volume (lower figure) for each month among various investor types in the TAIEX options contracts from April 2008 to December 2023. The gray bold curves represent percentages attributed to individual investors, while the red curves depict foreign institutional investors, and the blue dotted curves depict domestic institutional investors. The light gray shaded areas represent the aggregate values for each month.

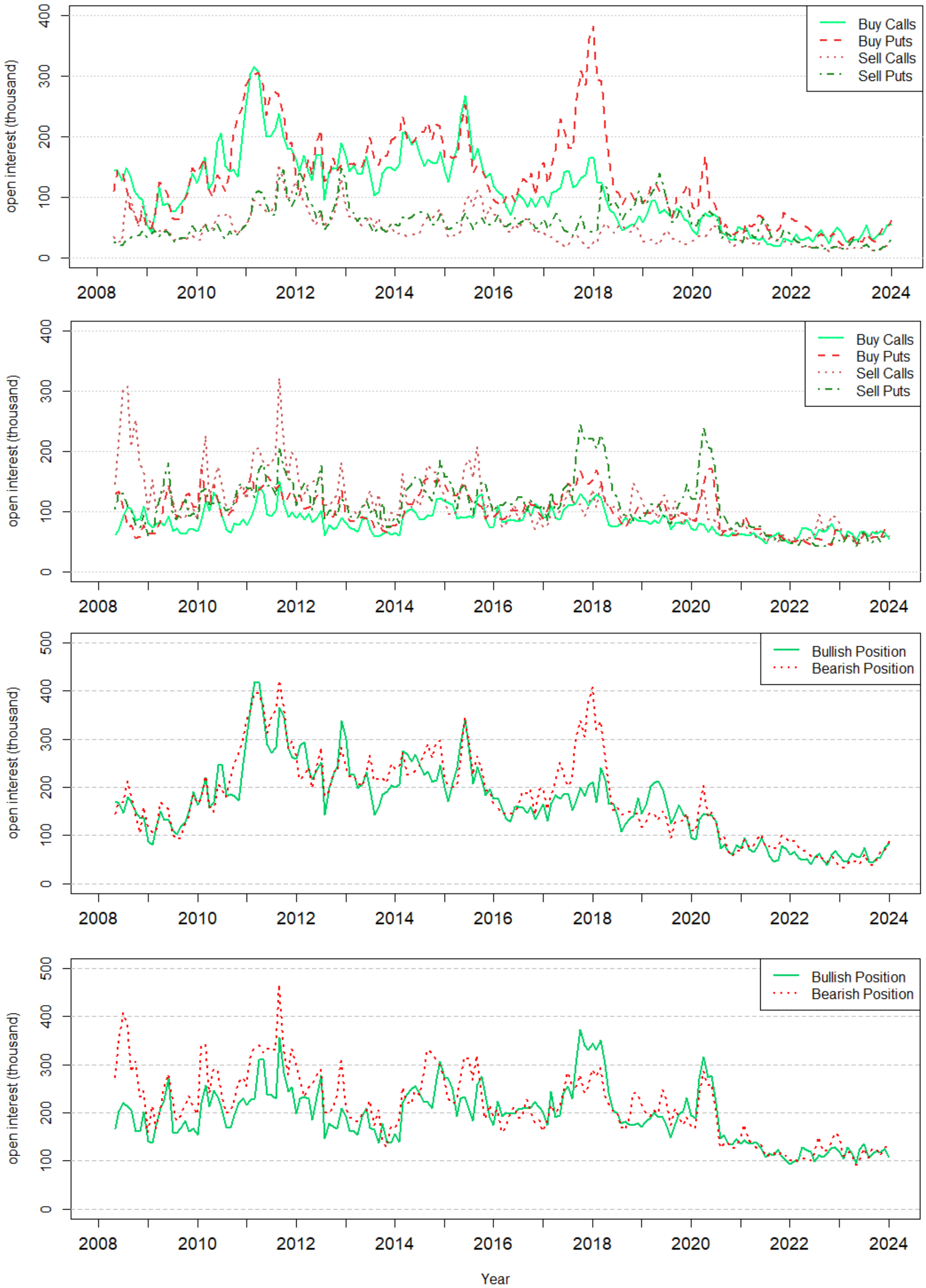

Figure 2. Average Daily TXO Open Interest for Institutional Investors

The top and second figures illustrate the average daily TXO open interest for foreign and domestic institutional investors' positions, respectively, for each month from April 2008 to December 2023. The third figure indicates bullish (buy calls plus sell puts) and bearish (buy puts plus sell calls) positions for foreign institutional investors, while the bottom figure shows these positions for domestic institutional investors.

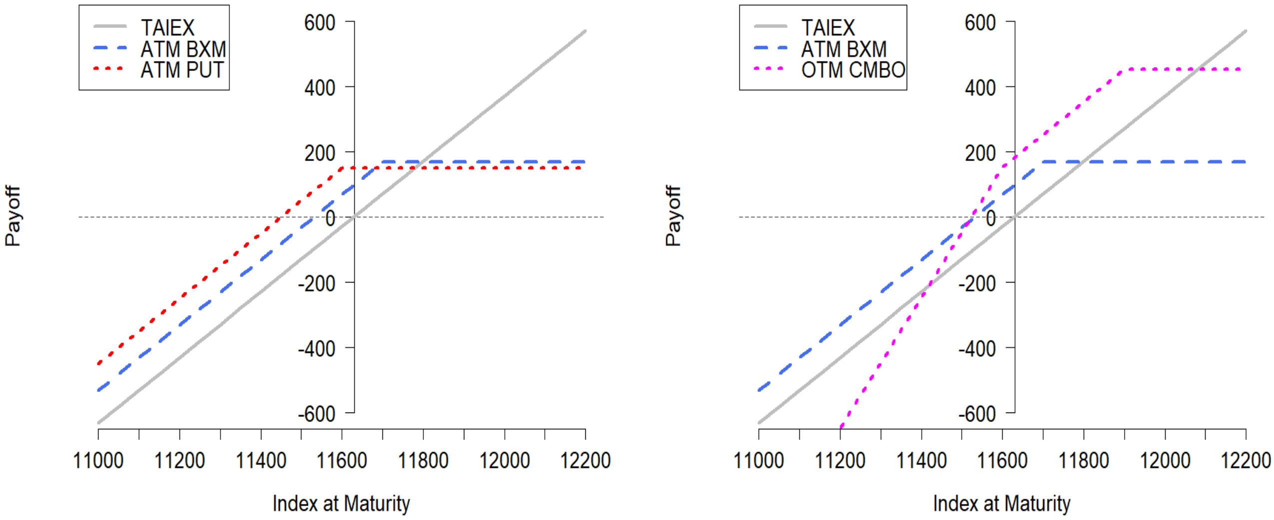

Figure 3. Payoffs for Option Writing Strategies

This figure displays the payoff functions for option writing strategies using the transaction data on November 20, 2019, with the benchmark being the underlying TAIEX holdings. The left figure shows the payoff functions for ATM buy-write and put-write strategies with a TAIEX level of 11,631 and strike prices of 11,600 for the put option and 11,700 for the call option. The right figure shows the payoff function for ATM buy-write strategy and a covered combo strategy with strike prices of 11,600 for the ATM put option and 11,900 for the 2% OTM call option.

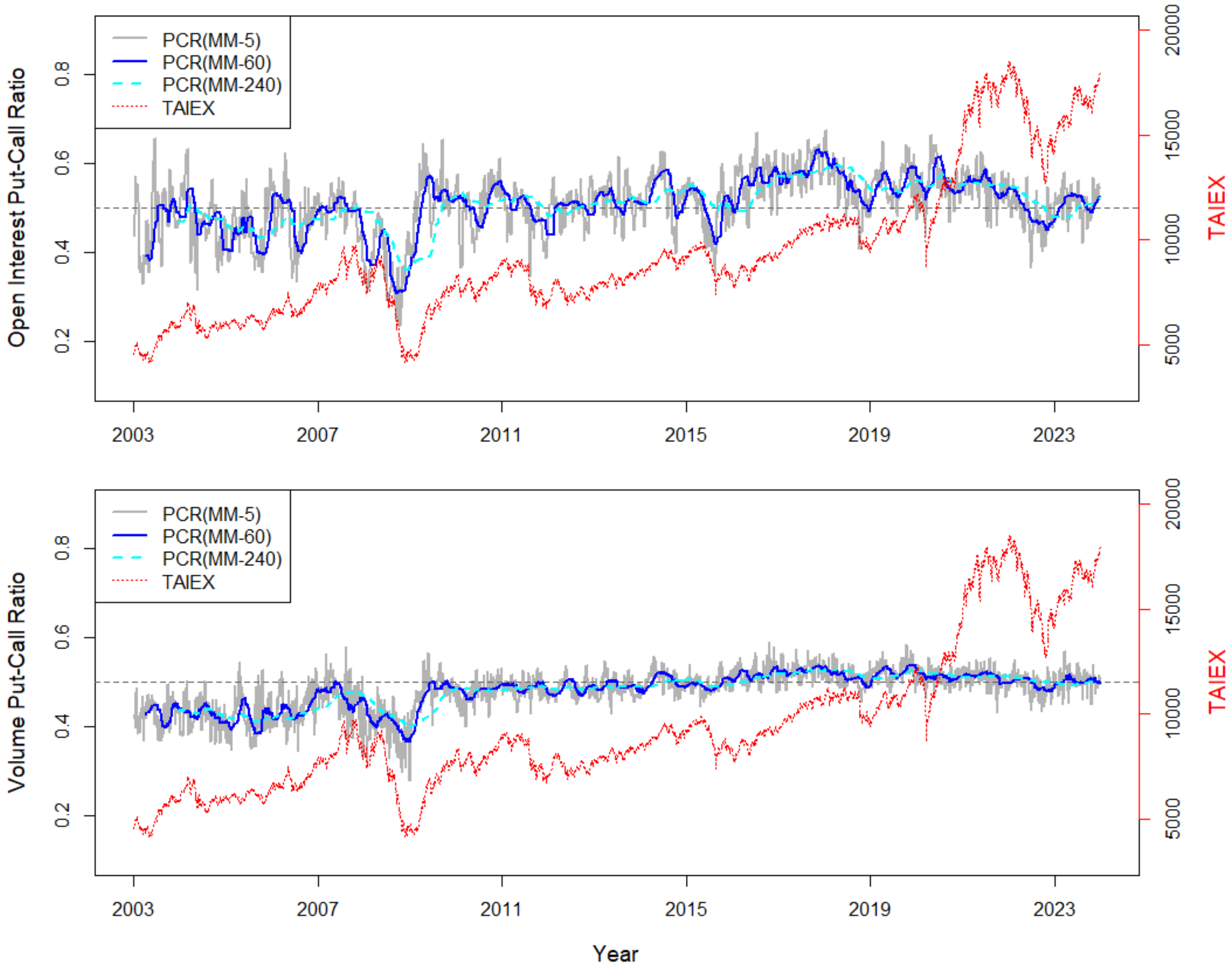

Figure 4. Moving Medians of Put-Call Ratio

This figure illustrates the moving medians (MM) of TXO's PCRs from 2003 to 2023, where the number 'k' in MM-k represents the rolling window. In the upper graph, the put-call ratio for each day is defined as the ratio of the total open interest of put options to the total open interest for that day. In the lower graph, it is defined as the ratio of the total volume of put options to the total volume for that day. TAIEX indicates the TAIEX Total Return Index (including cash dividends).

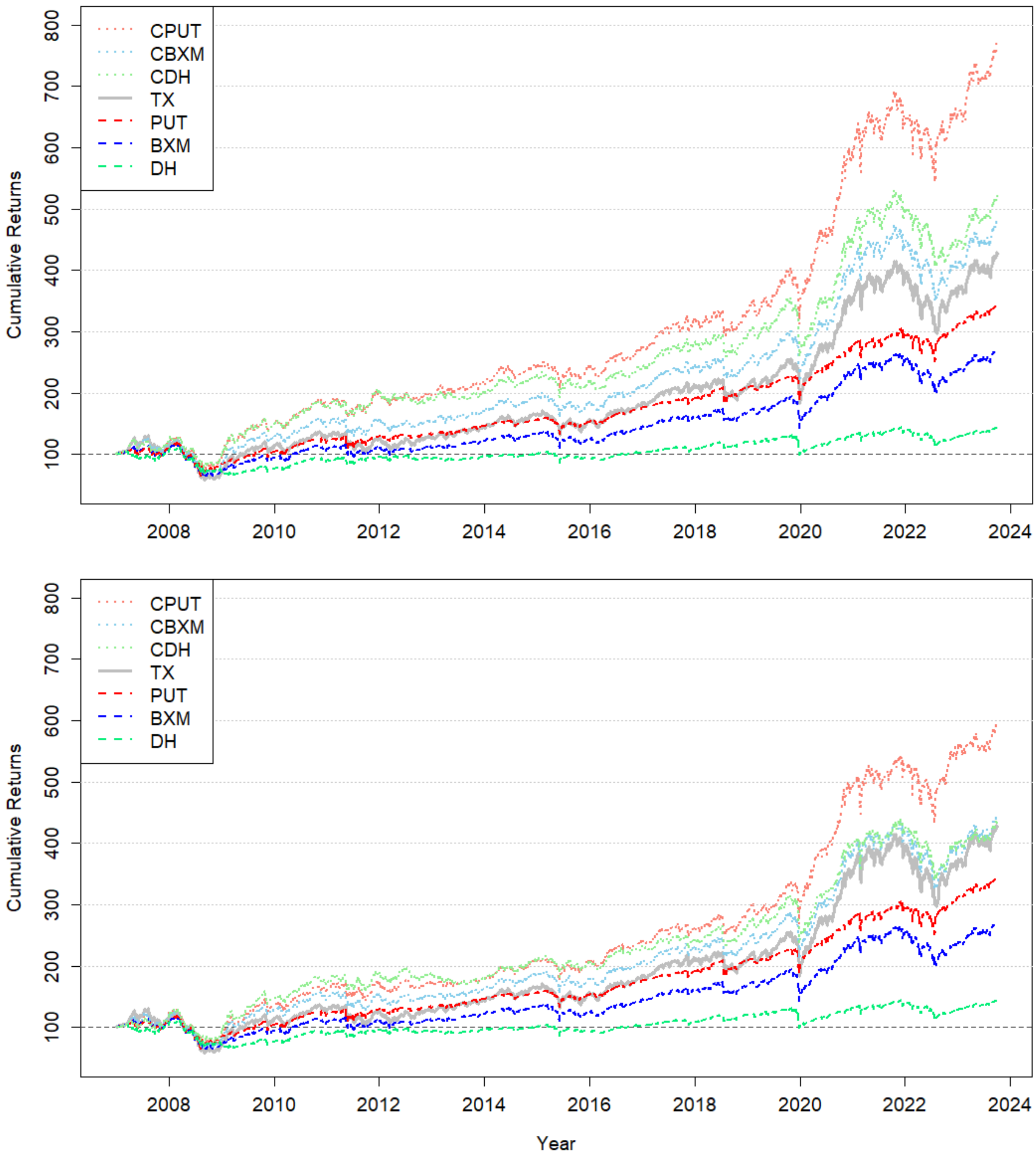

Figure 5. Cumulative Returns for Option Writing Strategies

This figure depicts the cumulative returns of conditional strategies CBXM (light blue dotted line), CPUT (light red dotted line), and CDH (light green dotted line) from March 21, 2007, to December 20, 2023. The upper graph depicts conditional strategies involving option writing only when the open interest PCR is less than 0.5. In the lower graph, conditional strategies involve writing options only when the 20-day moving median of open interest PCR is less than its 60-day moving median. The initial index is set as 100 (gray dotted line), and benchmarks include the TAIEX Total Return Index (gray solid line), as well as unconditional BXM (blue dashed line), PUT (red dashed line) and DH (green dashed line).

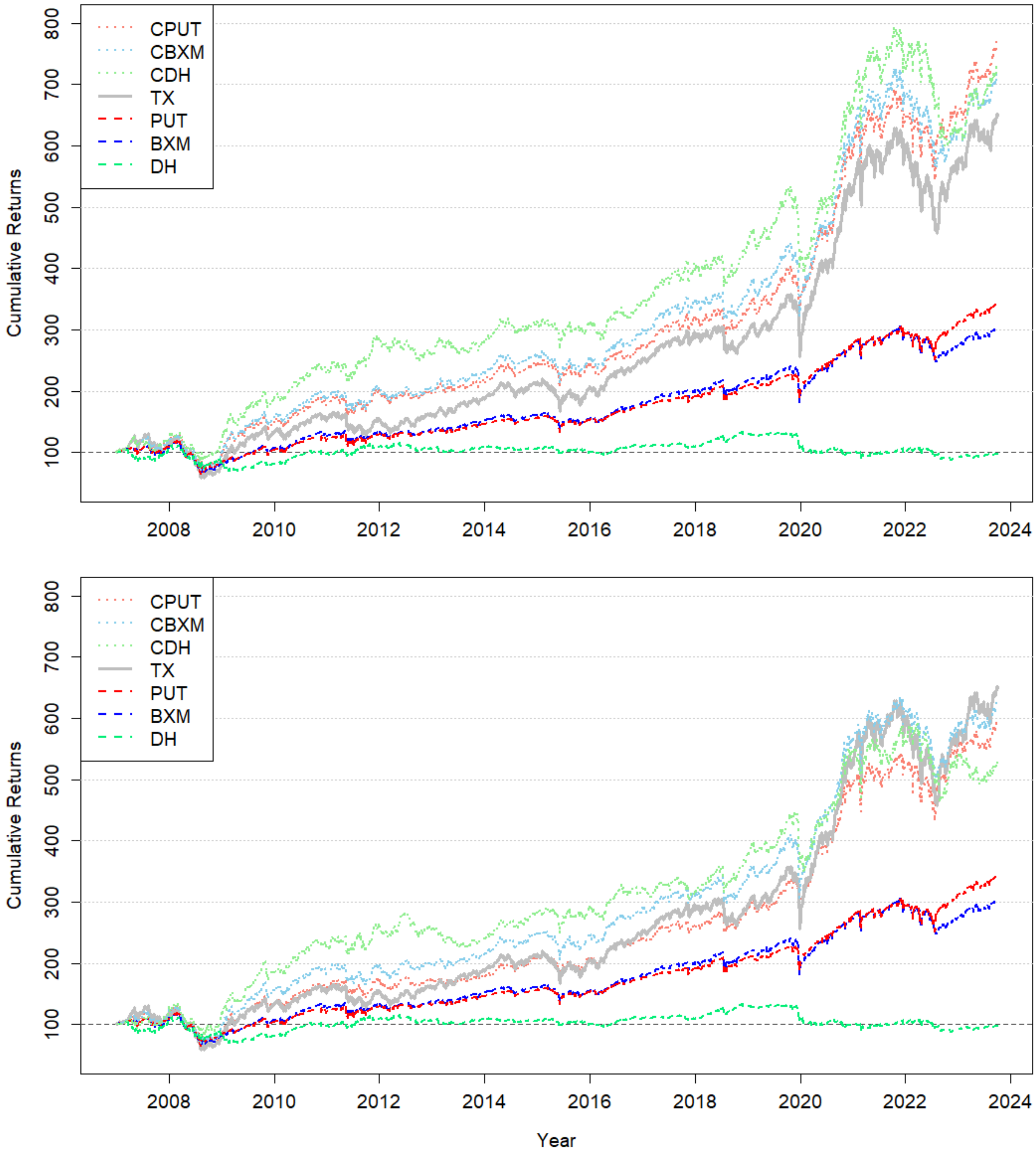

Figure 6. Cumulative Returns for Option Writing Strategies Using Futures Contracts

This figure depicts the cumulative returns of conditional strategies CBXM (light blue dotted line), CPUT (light red dotted line), and CDH (light green dotted line) from March 21, 2007, to December 20, 2023. In particular, the underlying index is replaced by nearby TAIEX futures (TX) contracts, which are rolling monthly. The upper graph depicts conditional strategies involving option writing only when the open interest PCR is less than 0.5. In the lower graph, conditional strategies involve writing options only when the 20-day moving median of open interest PCR is less than its 60-day moving median. The initial index is set as 100 (gray dotted line), and benchmarks include TX (gray solid line), as well as unconditional BXM (blue dashed line), PUT (red dashed line) and DH (green dashed line).

Table 1. Performance of Conventional and Conditional Option Writing Strategies

This table reports the performance of TAIEX and option writing strategies from March 2007 to December 2023 (a total of 201 months). TAIEX indicates the TAIEX Total Return Index, including cash dividends, while BXM (CBXM), PUT (CPUT), CMBO (CCMBO), and DH (CDH) denote (conditional) buy-write, put-write, covered combo, and delta-hedged strategies. The conditional strategies employ a fixed threshold for selling options when the open interest put-call ratio is below 0.5. Performance and risk measures are calculated using a daily index during the period. LPSD and MDD represent lower partial standard deviation and maximum drawdown, respectively. CAPM Alpha shows the intercept coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns, with standardized test statistics in parentheses testing if the alpha is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level. Trading costs account for 50% of the quoted spread and include margin costs.

	TAIEX	BXM	PUT	CMBO	DH	CBXM	CPUT	CCMBO	CDH
Panel A. Without Trading Costs									
Annualized Returns	15.27%	10.29%	12.69%	12.26%	4.45%	15.76%	20.41%	17.66%	16.39%
Standard Deviation	21.89%	17.20%	19.17%	17.91%	15.72%	19.55%	21.92%	20.24%	18.86%
Sharpe Ratio	0.58	0.48	0.55	0.58	0.15	0.71	0.86	0.79	0.78
LPSD	15.79%	12.93%	13.29%	13.27%	11.91%	14.24%	14.96%	14.55%	13.63%
Sortino Ratio	0.90	0.71	0.87	0.84	0.29	1.03	1.29	1.14	1.12
MDD	56.02%	46.19%	46.64%	45.87%	43.67%	47.33%	46.64%	45.87%	38.42%
CAPM Alpha	-	-1.24%	2.45%	0.52%	-2.69%	2.46%*	7.35%**	4.11%**	5.39%*
		(-0.726)	(0.643)	(0.253)	(-0.725)	(1.657)	(2.113)	(2.252)	(1.669)
Panel B. With Trading Costs									
Annualized Returns	15.27%	10.10%	12.32%	12.02%	4.02%	15.66%	20.22%	17.54%	16.18%
Standard Deviation	21.89%	17.20%	19.18%	17.91%	15.72%	19.55%	21.92%	20.24%	18.86%
Sharpe Ratio	0.58	0.47	0.53	0.56	0.13	0.70	0.85	0.78	0.77
LPSD	15.79%	12.94%	13.31%	13.28%	11.92%	14.25%	14.97%	14.55%	13.64%
Sortino Ratio	0.90	0.70	0.84	0.82	0.25	1.02	1.28	1.13	1.11
MDD	56.02%	46.30%	46.85%	46.04%	44.10%	47.64%	46.85%	46.11%	38.76%
CAPM Alpha	-	-1.43%	2.06%	0.28%	-3.12%	2.36%	7.15%**	3.99%**	5.18%
		(-0.841)	(0.542)	(0.138)	(-0.841)	(1.589)	(2.056)	(2.184)	(1.602)

Table 2. Performance of Conditional Option Writing Strategies Using Futures

This table reports the performance of TAIEX futures (TX) and conditional option writing strategies from March 2007 to December 2023 (a total of 201 months). TX indicates the nearby TAIEX futures rolling monthly, while BXM (CBXM), PUT (CPUT), CMBO (CCMBO), and DH (CDH) denote (conditional) buy-write, put-write, covered combo, and delta-hedged strategies. The conditional strategies employ a fixed threshold for selling options when the open interest put-call ratio is below 0.5. Performance and risk measures are calculated using a daily index during the period. LPSD and MDD represent lower partial standard deviation and maximum drawdown, respectively. CAPM Alpha shows the intercept coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns, with standardized test statistics in parentheses testing if the alpha is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level. Trading costs account for 50% of the quoted spread and include margin costs.

	TX	BXM	PUT	CMBO	DH	CBXM	CPUT	CCMBO	CDH
Panel A. Without Trading Costs									
Annualized Returns	19.51%	11.34%	12.69%	13.31%	1.26%	19.58%	21.91%	20.89%	19.66%
Standard Deviation	24.23%	17.48%	19.17%	18.66%	17.53%	20.90%	22.74%	21.78%	20.52%
Sharpe Ratio	0.70	0.54	0.55	0.61	-0.06	0.86	0.89	0.89	0.89
LPSD	17.24%	13.13%	13.29%	13.59%	13.38%	15.05%	15.50%	15.36%	14.71%
Sortino Ratio	1.07	0.78	0.87	0.90	0.02	1.23	1.34	1.29	1.26
MDD	55.46%	46.00%	46.64%	47.35%	40.88%	46.00%	46.72%	47.35%	37.07%
CAPM Alpha	-	-1.69%	0.13%	-0.46%	-4.00%	3.44%*	5.69%*	4.26%*	7.54%*
		(-0.764)	(0.039)	(-0.191)	(-0.417)	(1.781)	(1.755)	(1.948)	(1.763)
Panel B. With Trading Costs									
Annualized Returns	19.51%	11.04%	12.32%	13.01%	0.61%	19.44%	21.71%	20.74%	19.36%
Standard Deviation	24.23%	17.48%	19.18%	18.66%	17.53%	20.90%	22.75%	21.78%	20.52%
Sharpe Ratio	0.70	0.53	0.53	0.59	-0.10	0.85	0.88	0.88	0.87
LPSD	17.24%	13.14%	13.31%	13.60%	13.39%	15.06%	15.51%	15.36%	14.72%
Sortino Ratio	1.07	0.76	0.84	0.88	-0.03	1.22	1.33	1.28	1.24
MDD	55.46%	46.11%	46.85%	47.51%	41.45%	46.13%	47.18%	47.51%	37.44%
CAPM Alpha	-	-1.98%	-0.25%	-0.76%	-4.65%	3.30%*	5.49%*	4.10%*	7.23%*
		(-0.896)	(-0.072)	(-0.314)	(-0.943)	(1.707)	(1.693)	(1.878)	(1.691)

Table 3. Put-Call Ratios, VIX, and Index Returns by Quartile

This table reports the average values of the subsequent month's TAIEX log return (△TAIEX), BXM log return (△BXM), DH log return (△DH), and future change in VIXTWN (△VIX) in each quartile of independent variables. The data in Panels A, B, and C are sorted by the open interest put-call ratio (OIPCR), volume put-call ratio (VOLPCR), and the VIXTWN (VIX), respectively. The table also includes results of the *t*-tests examining the null hypothesis that the mean returns between Q4 and Q1 groups are equal to zero, with standardized test statistics reported in parentheses. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level.

	OIPCR	VOLPCR	VIX	△TAIEX	△BXM	△DH	△VIX
Panel A. OIPCR Quartile							
Q1	0.408	0.489	23.52	0.02%	-0.67%	-1.15%	-0.21
Q2	0.486	0.491	19.63	1.17%	0.26%	-0.40%	-0.70
Q3	0.545	0.483	17.96	0.67%	-0.12%	-0.74%	0.06
Q4	0.621	0.484	17.02	1.81%	0.64%	-0.25%	0.32
Q4-Q1				1.79%	1.31%	0.90%	0.53
				(1.48)	(1.68)	(1.21)	(0.66)
Panel B. VOLPCR Quartile							
Q1	0.524	0.437	21.06	-0.51%	-0.71%	-0.62%	0.16
Q2	0.526	0.471	19.44	0.47%	-0.29%	-0.76%	-0.09
Q3	0.523	0.493	19.68	0.77%	-0.05%	-0.60%	-0.67
Q4	0.521	0.526	17.43	1.92%	0.69%	-0.37%	0.46
Q4-Q1				2.43%**	1.40%*	0.25%	0.30
				(2.25)	(1.97)	(0.37)	(0.43)
Panel C. VIX Quartile							
Q1	0.574	0.489	12.60	0.83%	0.13%	-0.32%	0.72
Q2	0.536	0.489	15.34	0.45%	-0.33%	-0.81%	0.77
Q3	0.527	0.486	18.64	0.65%	-0.06%	-0.47%	0.56
Q4	0.472	0.476	29.32	1.51%	0.33%	-0.75%	-2.06
Q4-Q1				0.69%	0.20%	-0.42%	-2.78***
				(0.56)	(0.27)	(-0.56)	(-3.50)

Table 4. Comparisons with Alternative Signals

This table reports the performance of TAIEX, unconditional option writing strategies (UOWS), and conditional option writing strategies using various signals from March 2007 to December 2023 (a total of 201 months). Conditional option writing strategies are based on different signals: PCR (when the open interest put-call ratio is below 0.5), VIX (when the VIX is above 20), VIX-m, VRP, and JRP (when their 20-day moving medians exceed the 60-day moving median), and VJ (when VJ is positive). Panels A, B, C, and D present the results for the buy-write, put-write, covered combo, and delta-hedged strategies, respectively. Performance and risk measures are calculated using a daily index during the period. MDD represents the maximum drawdown. Number of Writing count months of option writing.

	TAIEX	UOWS	PCR	VIX	VIX-m	VRP	JRP	VJ
Panel A: Buy-Write Strategies								
Annualized Returns	15.27%	10.29%	15.76%	13.78%	14.56%	11.58%	13.44%	11.58%
Sharpe Ratio	0.58	0.48	0.71	0.63	0.65	0.46	0.57	0.54
Sortino Ratio	0.90	0.71	1.03	0.92	0.95	0.72	0.86	0.79
MDD	56.02%	46.19%	47.33%	46.19%	52.15%	51.73%	50.60%	47.52%
Panel B: Put-Write Strategies								
Annualized Returns	15.27%	12.69%	20.41%	17.42%	17.46%	13.13%	16.60%	14.73%
Sharpe Ratio	0.58	0.55	0.86	0.73	0.72	0.54	0.67	0.64
Sortino Ratio	0.90	0.87	1.29	1.12	1.11	0.84	1.04	0.99
MDD	56.02%	46.64%	46.64%	46.64%	52.76%	46.08%	49.57%	46.89%
Panel C: Covered Combo								
Annualized Returns	15.27%	12.26%	17.66%	15.44%	16.21%	12.96%	14.89%	13.37%
Sharpe Ratio	0.58	0.58	0.79	0.70	0.71	0.53	0.63	0.62
Sortino Ratio	0.90	0.84	1.14	1.01	1.04	0.81	0.94	0.90
MDD	56.02%	45.87%	45.87%	45.87%	51.06%	49.87%	49.49%	46.25%
Panel D: Delta-Hedged								
Annualized Returns	15.27%	4.46%	16.40%	12.34%	13.76%	7.29%	11.24%	7.31%
Sharpe Ratio	0.58	0.15	0.78	0.57	0.64	0.25	0.48	0.31
Sortino Ratio	0.90	0.29	1.12	0.85	0.94	0.44	0.73	0.50
MDD	56.02%	43.67%	38.43%	43.57%	47.70%	49.74%	46.38%	44.78%
Number of Writing	0	201	68	74	92	103	105	152

Table 5. Performance of Conditional Option Writing Strategies using Institutional Investors' Positions

This table reports the performance of conditional option writing strategies using institutional investors' positions from April 2008 to December 2023 (a total of 188 months). TAIEX indicates the TAIEX Total Return Index, including cash dividends, while CBXM, CPUT, CCMBO, and CDH denote conditional buy-write, conditional put-write, conditional covered combo, and conditional delta-hedged strategies. These conditional strategies employ a fixed threshold for writing options when the open interest put-call ratio for foreign (Panel A) or domestic (Panel B) institutional investors is below 0.5. Performance and risk measures are calculated using a daily index during the period. LPSD and MDD represent lower partial standard deviation and maximum drawdown, respectively. CAPM Alpha shows the intercept coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns, with standardized test statistics in parentheses testing if the alpha is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level.

		Buy Position				Sell Position			
	TAIEX	CBXM	CPUT	CCMBO	CDH	CBXM	CPUT	CCMBO	CDH
Panel A: Foreign Institutional Investors									
Annualized Returns	14.37%	13.62%	15.41%	14.53%	13.07%	13.25%	15.37%	14.42%	11.97%
Standard Deviation	21.29%	19.47%	21.67%	20.11%	18.89%	19.31%	21.69%	19.99%	18.67%
Sharpe Ratio	0.56	0.59	0.61	0.62	0.59	0.58	0.60	0.62	0.53
LPSD	15.32%	14.20%	14.85%	14.46%	13.77%	14.08%	14.82%	14.37%	13.62%
Sortino Ratio	0.87	0.90	0.98	0.94	0.90	0.88	0.98	0.94	0.83
MDD	53.59%	47.24%	48.08%	46.90%	40.37%	46.19%	46.64%	45.87%	37.99%
CAPM Alpha		0.74%	2.70%	1.44%	1.90%	0.50%	2.79%	1.45%	1.14%
		(0.540)	(0.800)	(0.823)	(0.518)	(0.356)	(0.802)	(0.803)	(0.371)
Panel B: Domestic Institutional Investors									
Annualized Returns	14.37%	13.24%	15.27%	14.32%	12.30%	13.46%	16.68%	14.95%	12.48%
Standard Deviation	21.29%	19.80%	22.12%	20.44%	19.26%	18.93%	21.10%	19.57%	18.04%
Sharpe Ratio	0.56	0.56	0.58	0.59	0.53	0.61	0.70	0.67	0.59
LPSD	15.32%	14.40%	15.13%	14.67%	14.01%	13.82%	14.41%	14.09%	13.15%
Sortino Ratio	0.87	0.85	0.94	0.91	0.80	0.91	1.10	1.00	0.89
MDD	53.59%	48.96%	50.06%	48.37%	43.17%	46.19%	46.64%	45.87%	37.99%
CAPM Alpha		0.09%	2.15%	0.95%	0.57%	0.98%	4.70%	2.29%	2.20%
		(0.072)	(0.650)	(0.576)	(0.212)	(0.678)	(1.303)	(1.232)	(0.702)

Table 6. Regression with Institutional Investors' Positions Controls

This table reports the results of time-series regressions examining the impact of PCR related variables on the subsequent month's TAIEX log returns (Panel A) and delta-hedged returns (Panel B). OIPCR and VOLPCR represent the open interest (OI) PCR and volume PCR, respectively. Control variables include RET (TAIEX log-return over the previous month), lnOITX (logarithm of TAIEX futures' OI), HV (annualized historical volatility), VRP (difference between realized volatility and the VIX index), JRP (difference in average implied volatilities between OTM and ATM put index options), VJ (sum of all daily increases in the average implied volatility of ATM call options that exceed 4%, or zero if no such increases occur), Ins-OIPCR (OIPCR using institutional investors' positions), and Ins-VOLPCR (VOLPCR using institutional investors' positions). Notably, institutional investors' positions encompass buy-positions (Buy) and sell-positions (Sell) for foreign (FI-) and domestic (DI-) institutional investors. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level. The sample period spans from April 2008 to December 2023.

	Aggregated	FI-Buy	FI-Sell	DI-Buy	DI-Sell
Panel A: TAIEX Return					
Intercept	-0.3707**	-0.4363**	-0.4306**	-0.4538**	-0.4702**
	(-2.014)	(-2.210)	(-2.085)	(-2.162)	(-2.327)
OIPCR	0.3047***	0.3703***	0.3667***	0.3521***	0.4047***
	(4.080)	(4.373)	(3.743)	(4.116)	(3.858)
VOLPCR	0.3548***	0.0967	0.4315***	0.3300	0.6747***
	(2.839)	(0.650)	(2.981)	(1.633)	(3.633)
RET	-0.3120***	-0.3392	-0.4255***	-0.3618**	-0.4145***
	(-2.792)	(-2.431)	(-2.662)	(-2.516)	(-2.873)
lnOITX	0.0007	0.0107	0.0037	0.0088	0.0123
	(0.044)	(0.613)	(0.200)	(0.476)	(0.682)
HV	0.1852**	0.1417*	0.1702*	0.1588*	0.1693*
	(2.197)	(1.691)	(1.946)	(1.803)	(1.963)
VRP	-0.3717***	-0.3457**	-0.4207***	-0.4114***	-0.3507**
	(-3.429)	(-2.548)	(-2.933)	(-2.915)	(-2.525)
JRP	-0.1966	-0.2441	-0.1873	-0.2686	-0.2522
	(-1.020)	(-1.208)	(-0.801)	(-1.282)	(-1.193)
VJ	0.0364	0.0719	0.0517	0.0459	0.0545
	(0.594)	(1.116)	(0.754)	(0.681)	(0.833)
Ins-OIPCR		-0.0443	-0.0035	-0.0682	0.0429
		(-0.774)	(-0.074)	(-1.224)	(0.612)
Ins-VOLPCR		0.1799***	-0.0745	0.0631	-0.4828**
		(3.517)	(-1.260)	(0.390)	(-2.549)
Adjusted R-squared	0.1606	0.2459	0.1833	0.1830	0.2144

Table 6. Regression with Institutional Investors' Positions Controls (cont'd)

	Aggregated	FI-Buy	FI-Sell	DI-Buy	DI-Sell
Panel B: Delta-Hedged Return					
Intercept	0.1839	0.0339	0.0125	0.0008	0.0260
	(1.465)	(0.260)	(0.095)	(0.006)	(0.197)
OIPCR	0.0050	0.1388**	0.1386**	0.1455***	0.1503**
	(0.099)	(2.482)	(2.218)	(2.725)	(2.200)
VOLPCR	-0.0377	-0.1506	-0.1077	-0.0942	-0.0711
	(-0.442)	(-1.534)	(-1.167)	(-0.747)	(-0.588)
RET	0.1401*	-0.1128	-0.1073	-0.1351	-0.1305
	(1.837)	(-1.225)	(-1.053)	(-1.506)	(-1.389)
lnOITX	-0.0166	-0.0060	-0.0046	-0.0065	-0.0063
	(-1.543)	(-0.520)	(-0.394)	(-0.561)	(-0.533)
HV	-0.1618***	-0.1396**	-0.1463***	-0.1414**	-0.1420**
	(-2.815)	(-2.525)	(-2.624)	(-2.571)	(-2.529)
VRP	-0.1220	-0.1425	-0.1437	-0.1320	-0.1529*
	(-1.650)	(-1.590)	(-1.571)	(-1.498)	(-1.691)
JRP	0.0964	0.0648	0.0827	0.1627	0.0978
	(0.733)	(0.486)	(0.554)	(1.244)	(0.710)
VJ	0.1311***	0.1666***	0.1622***	0.1720***	0.1609***
	(3.141)	(3.914)	(3.712)	(4.091)	(3.777)
Ins-OIPCR		0.0120	0.0008	0.0859**	-0.0074
		(0.318)	(0.025)	(2.469)	(-0.162)
Ins-VOLPCR		0.0418	0.0269	-0.0314	-0.0091
		(1.238)	(0.714)	(-0.310)	(-0.074)
Adjusted R-squared	0.0671	0.1551	0.1467	0.1821	0.1436

Table 7. Performance of Conditional Option Writing Strategies (Exclude Downtrends)

This table reports the CAPM alpha and beta of option writing strategies from March 2007 to December 2023. BXM (CBXM), PUT (CPUT), CMBO (CCMBO), and DH (CDH) denote (conditional) buy-write, put-write, covered combo, and delta-hedged strategies, respectively. The conditional strategies employ a fixed threshold for selling options when the open interest put-call ratio is below 0.5. Alpha (Beta) shows the intercept (slope) coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns in Panel A and on the TX returns in Panel B, with standardized test statistics in parentheses testing if the alpha is zero (beta is one). Downtrend indicates the period from July 2008 to December 2008 or March 2020, with standardized test statistics in parentheses testing if the coefficient is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level.

	BXM	PUT	CMBO	DH	CBXM	CPUT	CCMBO	CDH
Panel A: Regression of Portfolio Returns on the TAIEX Returns								
Alpha	-0.34%	2.99%	1.06%	-0.93%	2.34%	6.18%*	3.58%*	4.96%
	(-0.198)	(0.791)	(0.513)	(-0.246)	(1.577)	(1.747)	(1.922)	(1.536)
Alpha × Downtrend	-17.82%*	53.89%***	12.15%	-35.50%	-20.88%***	52.72%***	10.24%	-42.21%
	(-1.948)	(2.699)	(1.117)	(-1.780)	(-2.671)	(2.827)	(1.043)	(-2.481)
Beta	0.73***	0.59***	0.73***	0.43***	0.88***	0.83***	0.89***	0.75***
	(58.939)	(41.517)	(50.131)	(58.617)	(29.959)	(18.539)	(23.797)	(29.687)
Beta × Downtrend	0.03***	0.34***	0.13***	0.06**	-0.12***	0.10***	-0.02*	-0.27***
	(2.906)	(14.577)	(10.413)	(2.578)	(-13.082)	(4.783)	(-1.809)	(-13.468)
Panel B: Regression of Portfolio Returns on the TX Returns								
Alpha	-0.22%	1.44%	0.60%	-1.05%	3.28%*	5.02%	3.79%*	6.90%
	(-0.099)	(0.418)	(0.246)	(-0.211)	(1.683)	(1.521)	(1.706)	(1.604)
Alpha × Downtrend	-13.20%	23.07%	5.52%	-23.53%	-17.43%*	19.82%	2.35%	-33.06%
	(-1.129)	(1.276)	(0.433)	(-0.903)	(-1.707)	(1.144)	(0.201)	(-1.464)
Beta	0.63***	0.57***	0.66***	0.18***	0.84***	0.82***	0.86***	0.65***
	(69.689)	(51.830)	(58.387)	(68.566)	(33.751)	(22.280)	(26.755)	(33.258)
Beta × Downtrend	0.12***	0.26***	0.15***	0.25**	-0.10***	0.01	-0.05***	-0.22***
	(10.484)	(14.899)	(12.365)	(9.975)	(-9.845)	(0.516)	(-4.014)	(10.244)

Table 8. Option Writing Strategies with Weekly Rebalance

This table reports the performance of TAIEX and option writing strategies from March 2007 to December 2023 (a total of 201 months). TAIEX indicates the TAIEX Total Return Index, including cash dividends, while BXM (CBXM), PUT (CPUT), CMBO (CCMBO), and DH (CDH) denote (conditional) buy-write, put-write, covered combo, and delta-hedged strategies. The conditional strategies employ a fixed threshold for selling options when the open interest put-call ratio is below 0.5. Performance and risk measures are calculated using a daily index during the period. LPSD and MDD represent lower partial standard deviation and maximum drawdown, respectively. CAPM Alpha shows the intercept coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns, with standardized test statistics in parentheses testing if the alpha is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level. Trading costs account for 50% of the quoted spread and include margin costs.

	TAIEX	BXM	PUT	CMBO	DH	CBXM	CPUT	CCMBO	CDH
Panel A. Without Trading Costs									
Annualized Returns	15.27%	12.73%	15.78%	15.02%	9.06%	16.92%	21.74%	18.76%	18.81%
Standard Deviation	21.89%	16.71%	16.72%	17.11%	13.82%	19.15%	20.23%	19.54%	17.71%
Sharpe Ratio	0.58	0.66	0.87	0.79	0.55	0.80	1.09	0.89	1.01
LPSD	15.79%	12.68%	11.99%	12.92%	10.79%	13.95%	14.00%	14.18%	12.75%
Sortino Ratio	0.90	0.92	1.23	1.08	0.75	1.13	1.55	1.25	1.39
MDD	56.02%	56.02%	38.05%	42.59%	35.70%	44.03%	38.05%	42.59%	31.48%
CAPM Alpha	-	1.29%	6.24%**	3.39%**	2.41%	3.79%***	10.26%***	5.44%***	8.36%**
		(0.951)	(2.043)	(2.285)	(0.762)	(2.905)	(3.496)	(3.759)	(2.795)
Panel B. With Trading Costs									
Annualized Returns	15.27%	12.05%	14.21%	14.18%	7.54%	16.65%	21.85%	18.30%	18.20%
Standard Deviation	21.89%	16.71%	16.78%	17.13%	13.84%	19.15%	20.27%	19.55%	17.71%
Sharpe Ratio	0.58	0.62	0.76	0.74	0.43	0.78	1.03	0.86	0.97
LPSD	15.79%	12.69%	12.10%	12.96%	10.85%	13.96%	14.07%	14.21%	12.77%
Sortino Ratio	0.90	0.87	1.08	1.01	0.60	1.11	1.47	1.21	1.34
MDD	56.02%	43.29%	38.80%	43.16%	37.19%	44.75%	38.80%	43.16%	32.33%
CAPM Alpha	-	0.62%	4.64%	2.55%*	0.90%	3.53%***	9.35%***	4.98%***	7.76%***
		(0.452)	(1.514)	(1.710)	(0.284)	(2.700)	(3.180)	(3.429)	(2.590)

Table 9. Option Writing Strategies with Daily Rebalance

This table reports the performance of TAIEX and option writing strategies from March 2007 to December 2023 (a total of 201 months). TAIEX indicates the TAIEX Total Return Index, including cash dividends, while BXM (CBXM), PUT (CPUT), CMBO (CCMBO), and DH (CDH) denote (conditional) buy-write, put-write, covered combo, and delta-hedged strategies. The conditional strategies employ a fixed threshold for selling options when the open interest put-call ratio is below 0.5. Performance and risk measures are calculated using a daily index during the period. LPSD and MDD represent lower partial standard deviation and maximum drawdown, respectively. CAPM Alpha shows the intercept coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns, with standardized test statistics in parentheses testing if the alpha is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level. Trading costs account for 50% of the quoted spread and include margin costs.

	TAIEX	BXM	PUT	CMBO	DH	CBXM	CPUT	CCMBO	CDH
Panel A. Without Trading Costs									
Annualized Returns	15.27%	12.73%	13.58%	14.01%	9.79%	16.68%	20.83%	17.89%	18.52%
Standard Deviation	21.89%	16.17%	14.12%	16.28%	11.79%	18.72%	18.31%	18.89%	16.68%
Sharpe Ratio	0.58	0.69	0.88	0.77	0.73	0.81	1.10	0.87	1.06
LPSD	15.79%	12.30%	11.06%	12.46%	9.31%	13.63%	13.34%	13.81%	12.00%
Sortino Ratio	0.90	0.95	1.13	1.04	0.94	1.14	1.48	1.21	1.45
MDD	56.02%	42.21%	38.09%	41.84%	28.97%	44.85%	38.09%	42.19%	32.68%
CAPM Alpha	-	1.53%	4.38%**	2.65%***	3.68%	3.82%***	8.70%***	4.85%***	8.67%***
		(1.357)	(2.377)	(2.747)	(1.427)	(3.044)	(4.527)	(4.313)	(3.049)
Panel B. With Trading Costs									
Annualized Returns	15.27%	10.85%	8.61%	11.18%	5.64%	15.70%	18.24%	16.41%	16.35%
Standard Deviation	21.89%	16.14%	14.30%	16.34%	11.77%	18.71%	18.40%	18.93%	16.68%
Sharpe Ratio	0.58	0.56	0.49	0.58	0.36	0.75	0.92	0.78	0.91
LPSD	15.79%	12.35%	11.40%	12.61%	9.41%	13.66%	13.52%	13.91%	12.05%
Sortino Ratio	0.90	0.79	0.66	0.80	0.49	1.07	1.27	1.10	1.26
MDD	56.02%	44.44%	40.24%	44.14%	32.76%	47.18%	40.80%	45.55%	39.08%
CAPM Alpha	-	-0.32%	-0.70%	-0.20%	-0.41%	2.85%**	6.03%***	3.35%***	6.53%**
		(-0.282)	(-0.374)	(-0.203)	(-0.159)	(2.258)	(3.159)	(2.980)	(2.284)

Table 10. Robustness Checks for Alternative Moneyness

This table reports the performance of TAIEX and option writing strategies from March 2007 to December 2023 (a total of 201 months). TAIEX indicates the TAIEX Total Return Index, including cash dividends, while BXM (CBXM), PUT (CPUT), CMBO (CCMBO), and DH (CDH) denote (conditional) buy-write, put-write, covered combo, and delta-hedged strategies. The conditional strategies employ a fixed threshold for selling options when the open interest put-call ratio is below 0.5. Performance and risk measures are calculated using a daily index during the period. LPSD and MDD represent lower partial standard deviation and maximum drawdown, respectively. CAPM Alpha shows the intercept coefficients estimated from the time-series regression of portfolio returns on the TAIEX returns, with standardized test statistics in parentheses testing if the alpha is zero. One, two, and three asterisks (*), respectively, indicate the *t*-values are significant at the 10%, 5% and 1% level. Trading costs account for 50% of the quoted spread and include margin costs.

	TAIEX	BXM	PUT	CMBO	DH	CBXM	CPUT	CCMBO	CDH
Panel A. 2% OTM									
Annualized Returns	15.27%	12.05%	10.86%	12.75%	5.11%	16.02%	20.71%	17.95%	16.90%
Standard Deviation	21.89%	18.56%	17.63%	17.43%	18.12%	20.12%	21.48%	20.03%	19.83%
Sharpe Ratio	0.58	0.54	0.50	0.63	0.15	0.70	0.90	0.81	0.76
LPSD	15.79%	13.85%	11.35%	12.81%	13.67%	14.63%	14.06%	14.34%	14.26%
Sortino Ratio	0.90	0.79	0.86	0.91	0.30	1.02	1.39	1.17	1.11
MDD	56.02%	48.05%	44.02%	45.53%	46.30%	48.59%	44.28%	45.55%	40.38%
CAPM Alpha	-	-0.57%	2.61%	1.24%	-2.18%	2.20%*	8.68%**	4.54%**	6.03%
		(-0.376)	(0.647)	(0.647)	(-0.480)	(1.795)	(2.219)	(2.488)	(1.594)
Panel B. 4% OTM									
Annualized Returns	15.27%	13.80%	7.19%	12.79%	10.70%	16.20%	19.27%	19.11%	19.50%
Standard Deviation	21.89%	19.68%	14.54%	15.68%	21.51%	20.64%	19.60%	18.70%	21.10%
Sharpe Ratio	0.58	0.59	0.38	0.72	0.36	0.69	0.92	0.96	0.85
LPSD	15.79%	14.55%	10.07%	11.28%	16.19%	14.98%	13.54%	13.42%	15.09%
Sortino Ratio	0.90	0.87	0.61	1.04	0.59	1.01	1.34	1.34	1.22
MDD	56.02%	49.68%	39.96%	44.53%	48.03%	50.28%	42.15%	45.03%	42.28%
CAPM Alpha	-	0.28%	0.21%	7.25%*	3.10%	1.92%**	7.77%**	8.23%**	8.63%**
		(0.223)	(0.064)	(1.747)	(0.551)	(1.992)	(2.359)	(2.547)	(1.984)

Table 11. Robustness Checks for Alternative Moving Windows

This table reports the performance of TAIEX, unconditional option writing strategies (UOWS), and conditional option writing strategies from March 2007 to December 2023 (a total of 201 months). The columns labeled MM(x,y) represent the conditional strategies employing short-term x-day moving median and long-term y-day moving median. Panels A, B, C, and D present the results for the buy-write, put-write, covered combo, and delta-hedged strategies, respectively. Performance and risk measures are calculated using a daily index during the period. MDD represents the maximum drawdown. Number of Writing count months of option writing.

	TAIEX	UOWS	MM(20,60)	MM(1,60)	MM(5,60)	MM(5,240)	MM(20,240)	MM(60,240)
Panel A: Buy-Write Strategies								
Annualized Returns	15.27%	10.29%	15.08%	14.57%	13.80%	14.43%	14.70%	15.48%
Sharpe Ratio	0.58	0.48	0.67	0.64	0.59	0.64	0.66	0.71
Sortino Ratio	0.90	0.71	0.98	0.93	0.88	0.94	0.96	1.03
MDD	56.02%	46.19%	49.24%	49.78%	49.78%	47.99%	48.36%	46.77%
Panel B: Put-Write Strategies								
Annualized Returns	15.27%	12.69%	18.11%	17.93%	16.04%	17.55%	18.25%	19.10%
Sharpe Ratio	0.58	0.55	0.74	0.73	0.63	0.72	0.76	0.80
Sortino Ratio	0.90	0.87	1.14	1.12	1.00	1.11	1.16	1.22
MDD	56.02%	46.64%	49.19%	49.43%	49.43%	48.08%	48.08%	48.57%
Panel C: Covered Combo								
Annualized Returns	15.27%	12.26%	16.49%	16.07%	15.21%	16.02%	16.31%	17.03%
Sharpe Ratio	0.58	0.58	0.72	0.69	0.65	0.70	0.72	0.76
Sortino Ratio	0.90	0.84	1.05	1.02	0.96	1.03	1.05	1.11
MDD	56.02%	45.87%	48.65%	49.01%	49.01%	46.90%	46.90%	46.52%
Panel D: Delta-Hedged								
Annualized Returns	15.27%	4.46%	14.76%	13.67%	11.90%	13.33%	13.82%	15.68%
Sharpe Ratio	0.58	0.15	0.69	0.62	0.52	0.62	0.65	0.77
Sortino Ratio	0.90	0.29	1.01	0.92	0.79	0.91	0.95	1.10
MDD	56.02%	43.67%	43.56%	44.76%	44.76%	41.80%	41.80%	
Number of Writing	0	201	99	98	97	101	109	105

Appendix.

A1. Descriptive Statistics of TAIEX Options

Table A1 presents the descriptive statistics of TXO over our sample period. Panels A and B report summary statistics of call and put options, respectively. The variables include average implied volatility (IV), average open interest (OI), average trading volume (VOL), and the number of observations (N). Moneyness categories are defined as follows: DITM (deep in-the-money) for $m \leq 0.90$, ITM for $m \in (0.90, 0.97]$, NTM (near-the-money) for $m \in (0.97, 1.03]$, OTM for $m \in (1.03, 1.10]$, and DOTM (deep out-of-the-money) for $m > 1.1$. Here, moneyness (m) is defined as the strike price over the underlying index for call options and as the underlying index over the strike price for put options. TXO contracts are classified into near-term (days-to-maturity DTM $\leq$ 30), short-term (30 < DTM $\leq$ 60), mid-term (60 < DTM $\leq$ 90) groups. Contracts with more than 90 days to maturity or zero trading volume are excluded due to liquidity concerns.

<Table A1 is inserted about here>

The average implied volatility ranges from 0.13 (NTM, DTM≤ 30) to 0.34 (DOTM, DTM≤ 30) for call options and from 0.15 (NTM, DTM≤ 30) to 0.53 (DITM, DTM≤ 30) for put options. Notably, the volatility smile is more pronounced for short-term contracts, consistent with findings in the S&P 500 index option. Table A1 further indicates that NTM options with DTM less than 30 days exhibit higher liquidity in terms of both open interest and trading volume compared to other categories. Therefore, our option writing strategies will primarily focus on these contracts.

A2. Correlation Coefficients between Variables

First, consistent with Table 3, open interest PCR and volume PCR exhibit low correlation, with a coefficient of 0.024. Notably, open interest PCR correlates significantly with current TAIEX returns, with a coefficient of 0.750. Therefore, robustness checks are necessary if current returns are not controlled. Second, the correlation coefficient between the historical volatility and VIX is 0.856, leading us to exclude the VIX variable and incorporate the volatility risk premium as an independent variable. Third, due to the high correlation among some coefficients for the foreign institutional investors' ratios, only one position—either buy or sell PCR—is included in each regression model. Finally, domestic institutional investors' buy and sell volume PCRs are highly correlated with the aggregated volume PCR, with coefficients of 0.816 and 0.724, respectively.

<Table A2 is inserted about here>

Table A1. Descriptive Statistics

This table reports the descriptive statistics of Taiwan index options (TXO) trading from March 2007 to December 2023. Panels A and B report the summary statistics of call and put options, respectively. IV, VOL, OI, and N represent the average implied volatility, average trading volume, average open interest, and the number of observations, respectively. The moneyness categories are defined as follows: DITM (Deep in the money) for $m \leq 0.90$, ITM (in the money) for $m \in (0.90,0.97]$, NTM (near the money) for $m \in (0.97,1.03]$, OTM (out of the money) for $m \in (1.03,1.10]$, and DOTM (deep out of the money) for $m > 1.10$. Here, m denotes the moneyness, defined as the strike price over the underlying index for call options and as the underlying index over the strike price for put options. DTM represents days-to-maturity. TXO contracts are classified into near-term (days-to-maturity DTM $\leq$ 30), short-term (30 < DTM $\leq$ 60), and mid-term (60 < DTM $\leq$ 90) groups.

	DITM	ITM	NTM	OTM	DOTM
Panel A. TXO Call Options					
DTM $\leq$ 30					
IV	0.32	0.18	0.13	0.18	0.34
VOL	32.04	275.71	12,496.22	3,802.46	787.38
OI	458.59	1,521.54	9,701.80	10,166.69	5,069.67
N	8,900.	31,796.	67,638.	42,316.	23,961.
DTM $\in$ (30, 60]					
IV	0.22	0.15	0.15	0.15	0.20
VOL	16.42	63.62	1,221.12	1,260.12	248.83
OI	273.14	526.94	2,886.50	3,631.69	1,606.75
N	4,633.	16,945.	23,969.	26,715.	21,511.
DTM $\in$ (60, 90]					
IV	0.18	0.13	0.14	0.15	0.19
VOL	10.48	16.59	92.91	147.97	65.02
OI	393.46	385.57	617.63	896.68	898.31
N	1,762.	7,678.	19,029.	22,803.	15,770.
Panel B. TXO Put Options					
DTM $\leq$ 30					
IV	0.53	0.24	0.15	0.22	0.39
VOL	45.16	268.31	11,221.73	4,643.23	872.89
OI	746.11	1,264.23	7,652.69	11,023.55	5,640.58
N	4,888.	23,243.	66,873.	48,215.	50,525.
DTM $\in$ (30, 60]					
IV	0.39	0.23	0.20	0.21	0.28
VOL	25.97	50.54	798.93	1,395.34	362.93
OI	313.54	459.16	1,948.35	3,867.17	2,146.49
N	2,247.	12,027.	23,273.	25,105.	45,071.
DTM $\in$ (60, 90]					
IV	0.33	0.23	0.21	0.22	0.25
VOL	28.86	28.49	37.28	68.79	87.52
OI	396.30	414.39	482.98	872.34	1,518.69
N	1,747.	5,391.	14,681.	20,373.	55,150.

Table A2. Correlation between Variables

This table displays correlation coefficients between key variables for subsequent regressions. OIPCR and VOLPCR indicate open interest PCR and volume PCR, RET represents TAIEX log-return over the previous month, lnOITX is the logarithm of TAIEX futures' OI, HV denotes annualized historical volatility, and VIX shows TAIEX Options volatility index. VRP shows variance risk premium using the difference between realized volatility and the VIX index. JRP shows the difference in average implied volatilities between OTM and ATM put index options. VJ calculates the sum of all daily increases in the average implied volatility of ATM call options that exceed 4%, or zero if no such increases occur. FOPCRb (FVPCRb) and FOPCRs (FVPCRs) denote OI (volume) PCR using foreign institutional investors' buy and sell positions, respectively. DOPCRb (DVPCRb) and DOPCRs (DVPCRs) denote OI (volume) PCR using domestic institutional investors' buy and sell positions, respectively.

	OIPCR	VOLPCR	RET	lnOITX	HV	VIX	VRP	JRP	VJ	FOPCRb	FOPCRs	FVPCRb	FVPCRs	DOPCRb	DOPCRs	DVPCRb
VOLPCR	0.024															
RET	0.750	-0.201														
lnOITX	0.354	0.221	-0.016													
HV	-0.267	-0.314	0.041	-0.501												
VIX	-0.452	-0.260	-0.187	-0.393	0.856											
VRP	-0.227	-0.041	-0.306	0.033	-0.063	0.069										
JRP	0.246	0.097	0.071	0.349	-0.159	-0.046	-0.050									
VJ	-0.319	-0.085	-0.297	-0.187	0.466	0.696	0.371	0.119								
FOPCRb	0.376	0.273	0.080	0.444	-0.397	-0.372	-0.033	0.311	-0.208							
FOPCRs	0.483	0.246	0.075	0.580	-0.410	-0.469	0.013	0.501	-0.216	0.546						
FVPCRb	-0.035	0.598	-0.185	0.159	-0.210	-0.203	-0.115	0.117	-0.111	0.279	0.209					
FVPCRs	-0.187	0.490	-0.341	-0.114	-0.014	-0.021	-0.099	0.068	0.049	-0.042	0.067	0.423				
DOPCRb	0.018	0.221	0.027	-0.193	-0.090	-0.219	-0.155	-0.222	-0.219	0.108	0.023	0.099	0.097			
DOPCRs	0.677	0.276	0.363	0.401	-0.416	-0.442	-0.151	0.414	-0.236	0.468	0.498	0.188	-0.028	-0.052		
DVPCRb	-0.070	0.813	-0.242	0.157	-0.314	-0.233	-0.002	0.068	-0.038	0.203	0.192	0.484	0.440	0.263	0.203	
DVPCRs	0.307	0.724	-0.015	0.372	-0.344	-0.320	0.018	0.148	-0.109	0.268	0.371	0.295	0.199	0.143	0.417	0.489