Warrant informed trading prior to monthly-revenue disclosures: Evidence from the Taiwan market

Chao-Chun Chen[1] Che-Chia Chang[2] Pin-Yu Huang[3]

Abstract

As a particular regulation for information disclosures promulgated by the Securities Exchange Act in Taiwan, listed firms are required to disclose net operating revenues of the preceding month within the first ten calendar days of each month. This research adopts implied volatility skew as a proxy for informed trading and examines the information content of warrant trading prior to monthly-revenue announcements in Taiwan accordingly. We note that the short-selling prohibition in Taiwan's warrant market forbids investors from performing any of the trading strategies that concurrently involve long and short positions of warrants, such as bull spread, bear spread, and strangle write. Since derivative positions may contain complicated information when they are a part of strategic trading, the short-selling restriction in the warrant market allows the measurement of warrant informed trading to get rid of noisy information arising from these forms of strategic trading. We find a significantly negative relation between abnormal IV skew of warrants and cumulative abnormal stock return (CAR) around the subsequent monthly-revenue disclosure by employing samples consisting of the top 20 and top 10 most popular warranted stocks, respectively. This predictability is stronger for high-priced stocks and more evident for revenue-reduction surprises. These findings suggest that informed trading is the driving force behind the warrant market activities prior to monthly-revenue reporting.

Key words: Warrant informed trading; Disclosure of monthly revenues; Implied volatility skew; Predictability, Short-selling prohibition

We acknowledge the financial support from the National Science and Technology Council of Taiwan (MOST 107-2410-H-029-014 -).

[1] Chao-Chun Chen, E-mail: jawjiun@thu.edu.tw, Associate Professor in the Department of Finance, Tunghai University, Taichung, Taiwan.

[2] Corresponding author: Che-Chia Chang, E-mail: ccchang@thu.edu.tw, Associate Professor in the Department of Finance, Tunghai University, No. 1727, Sec. 4, Taiwan Boulevard, Xitun District, Taichung City 407224, Taiwan (R.O.C.), Tel.: (886) 4-23590121, ext. 35819, Fax: (886) 4-23506835.

[3] Pin-Yu Huang, Department of Finance, Tunghai University, Taichung, Taiwan.

1 Introduction

Informed traders prefer to exploit their private information in a derivatives market more than to do so in its underlying stock market, because trades on financial derivatives enable traders to enjoy higher financial leverage, lower transaction costs, and opportunities of speculation on volatility. When informed traders choose derivatives markets as their trading venue, derivatives prices may contain information regarding future movements of stock prices. Following this view, a growing body of literature has emerged examining the information content of option informed trading prior to important informational events, including announcements for merger and acquisition (Cao, Chen, and Griffin, 2005; Jayaraman, Augustin, Brenner, and Subrahmanyam, 2015; Chan, Ge, and Lin, 2015), earnings announcements (Jin, Livnat, and Zhang, 2012), share-repurchase announcements (Hao, 2016), stock-split announcements (Gharghori, Maberly, and Nguyen, 2017), and announcements for dividend changes (Zhang, 2018). These documents provide evidence suggesting that information conveyed in pre-event option trading predicts the subsequent stock returns. However, studies on option informed trading are inconclusive. Chiang and Fung (2001) and Chan, Chung, and Fung (2002) find no evidence supporting the notion that information is disseminated from the option market to its underlying stock market.

This study contributes to the existing literature on informed trading by investigating the information content of warrant trading prior to monthly-revenue reporting in Taiwan. For the purpose of information disclosures and protection of investors, Article 36 of the Securities Exchange Act of Taiwan requires listed firms to publicly announce and register with the Financial Supervisory Commission their operating status of the preceding month within the first ten days of each calendar month. Unlike the case of the U.S., where investors have little public information about firms' operating performance before quarterly financial statements are filed, the monthly-revenue disclosures in Taiwan allow investors to realize firms' operating status far earlier than the release of quarterly financial reports. Chen and Yu (2022) document the distinct informativeness of monthly-revenue reports, especially in providing leading information for investors to comprehend firms' fundamentals and in facilitating investors to predict future earnings surprises more precisely.

Zhang (2018) points out that distinguishing informed trading from participation induced by market rumor or by market anticipation is difficult. Under this concern, investigating informed trading in case of a well-anticipated event should be complicated. As we mention above, Article 36 of the Securities Exchange Act requires listed firms to disclose unaudited net operating revenues of the preceding month promptly within a very short period of time - that is, ten calendar days following the end of the preceding month. Collecting information and anticipating well the recent operating performance of firms within such a short period of time is not easy in most cases, leading firms' monthly revenues to seldom be anticipated well before monthly reporting. This also leads few market rumors about monthly revenues circulating before monthly reporting. These features enable the event of monthly-revenue announcements performed by listed firms in Taiwan to provide a clean set-up in examining whether informed traders are the driving force behind activities of derivatives markets before the interim revenue disclosures.

Option-based variables, such as implied volatility spreads, implied volatility skew, and option trading volume, are found to be significantly associated with impending stock returns by a large amount of literature. The information effect of warrant trading, however, is not understood yet. In addition to highlighting how securities prices react to interim accounting disclosures as we note above, another contribution of this study to the related literature is to examine the information content of informed trading in a warrant market rather than in an option market.

Call/put warrants are securities that give holders the right to buy/sell the underlying securities from/to the warrant issuer at a given strike price for an agreed-upon quantity within a prescribed period of time or by a prescribed maturity date. Particularly, warrants are issued by a third party other than the issuers of the underlying securities. Although warrants are option-like derivatives, Chan and Wei (2005) point out that the two derivatives markets are different on many aspects. First, unlike the well-known features of option markets that there are usually designated market makers assigned in an option market and the option listing is sponsored by the exchange, warrant issuing companies are the liquidity providers and underwriters for their own warrants. Second, the warrant listing market functions as a market for IPOs and SEOs, while the option listing market operates in matching buyers

and sellers together. Finally, as the most distinguishable feature of the warrant market from the option market for traders in Taiwan, investors are prohibited from selling short warrants. The short-selling prohibition prevents traders from adopting any types of trading strategies involving short positions of warrants, including bull spread, bear spread, butterfly spread, straddle write, and strangle write. The different institutional settings between these two derivatives markets lead warrants to differ from standard exchange-traded options in many respects, including the price characteristics, transaction structure, and trading strategy undertaken by investors. To the best of our knowledge, this study represents the first in examining the information conveyed by trades in derivative warrant markets prior to important informational events, in which individual investors are major participants and short-sales of warrants are not allowed.

This study adopts implied volatility skew, IV skew hereafter, as a proxy for informed trading. We note that measuring informed trading without getting rid of influences resulting from complicated strategic trading that concurrently involves long and short positions of derivatives is of potential concern among studies on option informed trading. Specifically, investors in an option market are able to bet on future price movements of the underlying asset by taking a single option position or by adopting trading strategies involving multiple positions of options. To illustrate, a bull spread created using put options, which consists of a short position in at-the-money (ATM) put options and a long position in out-of-the-money (OTM) put options, is appropriate for investors with a bullish view on price movements of the underlying asset. As a part of this bull spread, the long position of OTM put options does not contain information that the underlying stock prices would fall as its single position does. These noisy signals resulting from complicated strategic trading may weaken the information content of informed trading measures, including IV spread, IV skew, and put-call ratio. Fortunately, the short-selling prohibition in the warrant market of Taiwan forbids investors from performing any trading strategies that involve both long and short positions of warrants. This allows us to measure warrant informed trading by excluding complex information arising from strategic trading as best as possible. This is also a remarkable contribution of this study.

This study overall is built based on prior research supporting the predictive power of options' IV

skew on stock returns and on literature suggesting the price effects of revenue information. With the unique sample from the Taiwan market, in which listed firms are required to disclose unaudited revenues monthly and a considerable amount of derivative warrants are listed and traded, this study contributes to the literature on informed trading by relating warrant informed trading and abnormal stock return surrounding the interim accounting disclosures. Our empirical findings suggest that warrant informed trading, as proxied by abnormal IV skew of warrants, does possess predictability on two-day cumulative abnormal stock return (CAR) around the subsequent monthly-revenue announcement.

The remainder of this paper is organized as follows. Section 2 discusses the market and institutional background as well as empirical hypotheses. Sections 3 and 4 present the research design and sample description, respectively. The empirical results are reported in Section 5, with the conclusions provided in Section 6.

2 The background and hypotheses

2.1 Market and institutional background

In addition to publicly announcing quarterly and annual financial reports that are duly reviewed by a certified public accountant, listed firms in Taiwan are required to provide unaudited net operating revenues monthly since 1988. Specifically, listed firms publicly announce the recent operating status, including net operating revenues of the preceding month and net operating revenues accumulated in that year, within the first ten days of each month.

The timing of interim monthly revenue disclosures in Taiwan is far earlier than that of quarterly earnings announcements. Specifically, listed firms shall disclose monthly revenues within the first ten days of each month, while the quarterly and annually financial reports duly audited and attested by a certified public accountant should be performed within 45 days after the end of the first, second, and third quarters of each fiscal year and within three months after the close of each fiscal year, respectively. The timing of these accounting disclosures enables monthly-revenue announcements to convey timely and leading information about firms' succeeding quarterly earnings.

It is well known that earnings and concurrent revenues are disclosed simultaneously in financial reports in most countries, including the United States. Findings of related literature suggest that

revenue information is value relevant and stock prices react to revenue surprises released in formally financial reports, including Ertimur, Livnat, and Martikainen (2003), Kim, Lim, and Park (2009), Chen, Chen, Hsin, and Lee (2014), and Beaver, McNichols, and Wang (2018), to name a few. By highlighting the information value of monthly-revenue announcements in Taiwan, Chen and Yu (2022) find that the interim accounting information has significant influences on analysts' earnings forecasts and is helpful for investors in better predicting future earnings surprises. Accordingly, they document that the mandatory interim revenue disclosures facilitate improving the transparency of disclosures and the protection of investors in Taiwan.

Using the top 20 warranted-stock sample that contains 1,275 monthly-revenue disclosures over the period January 2014 through July 2022 in Taiwan, we depict the average and standard deviation of abnormal stock return on each day over the [−5, +5] event window around disclosures of monthly revenue growth in Figure 1. Similarly, Figure 2 displays the daily evolution of the average and standard deviation of abnormal stock return around announcements of monthly revenues that achieve a record high. Abnormal return is measured as daily stock return of monthly-revenue announcing firms in excess of the return on the Taiwan Capitalization Weighted Stock Index (TAIEX) on the same date. We rank a stock by the amount of warrant contracts that underlie it each year, and the top 20 warranted-stock classes are the 20 most popular. Moreover, date 0 is the monthly-revenue announcement day.

As Figures 1 and 2 exhibit, both the average and standard deviation of abnormal return go up dramatically in reaction to revenue-growth surprises. Figures 3 and 4 plot the daily evolution of the average and standard deviation of abnormal stock return around announcements of monthly revenue reduction and those surrounding announcements of record-low monthly revenues, respectively. As expected, average abnormal stock return drops clear in response to revenue-reduction shocks, while standard deviation of abnormal stock return jumps obviously after announcement dates. Both the information effects of monthly-revenue disclosures suggested in the above-mentioned literature and reactions of stock prices to monthly-revenue reporting found in Figures 1-4 attract us to shed light on whether there is clustering by a high proportion of informed traders in a derivatives market, which is a trading venue preferred particularly by informed traders, prior to monthly-revenue disclosures. We note that derivatives informed trading prior to monthly-revenue surprises has not been investigated in the existing literature yet. Since disclosures of monthly revenues are characterized as timely and seldom well-predictable events, these features facilitate us to investigate this issue under a cleaner setting.

It is also worth noting that our study contributes to the literature on derivatives informed trading by first examining the information content of warrant trading prior to important informational events. The warrant market was introduced in Taiwan in June 1997 and by 2014 ranked as the top five largest warrant market in terms of trading value around the world. The trading volume of Taiwan's warrant market hit its top in 2018. According to the statistics of the Taiwan Stock Exchange (TWSE), 723,926 million contracts of warrants traded during that year. Individual investors are the major participants in the warrant market, while few institutional investors participate in this market.

Equity derivative warrants are well-known as option-like instruments, but with features distinguishable from stock options. Summarily, warrants and options differ at least on the following three dimensions. First, derivative warrants are issued only by specific authorized institutions. Warrant issuers sponsor warrants and provide liquidity to the secondary market of warrants, whereas the exchange is the underwriter for option listing and there are designated market makers supplying liquidity in the option market. Second, warrants are traded at prices different from prices of otherwise identical options in general. Numerous studies relate this phenomenon to limits of arbitrage and liquidity premium of derivative warrants. Findings of related studies, including Chang, Luo, Shi, and Zhang, (2013), Tang and Wang (2013), and Xiong and Yu (2011), conclusively indicate that warrants are priced by mechanisms other than those suggested by traditional option theories. Finally, there may be a pronounced number of warrant contracts that underlie the same security, especially for popular underlying stocks. Unlike the mechanics of option markets, issuers of warrants on the same underlying stock compete with each other by providing various contract specifications, lower implied volatility, or better liquidity. Although derivative warrants differ from options evidently on many dimensions, literature related to derivatives informed trading only focuses itself on the option market. The aim of this study is to fill the gap in the literature.

As we remark above, derivative positions may contain complicated information when they are parts of trading strategies that concurrently involve long and short positions of derivatives. Fortunately, the presence of short-selling constraints in the warrant market prevents the measurement of warrant informed trading from disturbances of noisy information arising from strategic trading. This advantage also attracts us to contribute the existing studies in examining the information effects of warrant informed trading.

2.2 Hypotheses' development

As Zhang (2018) points out, the information advantage of informed traders may come from their superior capability on possessing public information and/or particular information leakage of insiders. Due to the information advantage and preferred trading venue of informed traders, informed trading activities would be active in derivative markets prior to informational events. Accordingly, this study adopts IV skew as a proxy for warrant informed trading and investigates the information content of warrant trading prior to disclosures of monthly revenues in Taiwan based upon it.[4]

Consistent with the method of Xing, Zhang, and Zhao (2010) and Zhang (2018), the IV skew is defined as the difference between implied volatility of the OTM put warrant and that of the ATM call warrant. Intuitively, trading on information concerning an impending downward/upward movement in stock prices raises prices of put/call warrants and results in a higher/smaller IV skew of warrants. As a result, an increase in warrants' IV skew predicts a drop in subsequent stock prices, while a reduction in warrants' IV skew would be followed by a rise in stock prices. Literature on option informed trading, including Bali and Murray (2013), Chan et al. (2015), Hao (2016), Jin et al. (2012), and Zhang (2018), provides evidence supporting the return predictability of options' IV skew prior to important informational events. This study devotes effort in relating warrant informed trading and CAR around monthly-revenue announcements, which are distinctive and important informational events in Taiwan's securities market.

The following Hypothesis 1 summarizes the main test of this study.

> **Hypothesis 1.** The IV skew of warrants is negatively associated with cumulative abnormal stock return around the subsequent monthly-revenue announcement.

The predictability of warrants' IV skew can be attributed to warrant informed trading prior to monthly-revenue surprises. Particularly, the more the informed investors utilize their private information in the derivative warrant market, the more is the informativeness of warrants' IV skew. Contrarily, when more investors choose to exploit their private information in the stock market, information concerning the upcoming news would be reflected by stock returns prior to monthly-revenue disclosures, reducing the information advantage of warrant informed traders. As a result, less informed traders participating in the warrant market and lower information advantage of warrant informed traders weaken the informativeness conveyed in warrant trading. Hypothesis 2 summarizes

[4] This study does not adopt the IV spread as an informed trading measure of warrants, because there are few stocks that have pairs of put and call warrants with matching strike price and expiration date outstanding in Taiwan.

the above reasoning.

> **Hypothesis 2.** The predictability of warrants' IV skew on cumulative abnormal stock return around the successive monthly-revenue disclosure weakens when information about unpublished operating performances of listed firms has been incorporated into their stock prices prior to announcement dates.

Short selling stocks generally incurs more trading costs and imposes more trading constraints than buying put warrants does. As a result, warrant markets attract informed traders more when upcoming bad news is known to them than when they have private information about unpublished good news. Consistent with this view, the predictability of warrants' IV skew on abnormal stock returns surrounding the following announcements would be asymmetric among revenue-reduction surprises and revenue-growth surprises. We summarize the above reasoning and state the asymmetric predictability of warrants' IV skew in the following hypothesis.

> **Hypothesis 3.** The predictability of warrants' IV skew with regard to cumulative abnormal stock return around the following monthly-revenue disclosure is more pronounced for revenue-reduction surprises than for revenue-growth surprises.

As taking a position in call/put warrants can be regarded as taking a leveraged long/short position in the underlying asset, derivative warrants are more accessible and more attractive to informed traders with limited funds, especially when they hold private information associated with high-priced stocks. It leads the predictability of warrants' IV skew to being stronger for high-priced stocks than for non-high-priced stocks. Hypothesis 4 formally summarizes the above intuition.

> **Hypothesis 4.** The negative relation between IV skew of warrants and cumulative abnormal stock return around the subsequently monthly-revenue disclosure is stronger for high-priced stocks than for non-high-priced stocks.

3 Research design

3.1 Measure of warrant informed trading

This study adopts IV skew as a proxy for warrant informed trading and captures the perspective of warrant traders on the successive stock return based on it. This subsection describes the ways to calculate IV skew and abnormal IV skew of warrants.

We follow the method of Xing et al. (2010) and Zhang (2018) and measure warrants' IV skew as the difference in implied volatilities between OTM put warrants and ATM call warrants on the same underlying stock. Specifically, IV skew of warrants for firm i on day t, $IVSkew_{i,t}$, is calculated as:

$$IVSkew_{i,t} = IV_{i,t}^{OTMP} - IV_{i,t}^{ATMC}, \quad (1)$$

where $IV_{i,t}^{OTMP}$ is the average of Black-Scholes implied volatility of OTM put warrants, and $IV_{i,t}^{ATMC}$ denotes the average of Black-Scholes implied volatility of ATM call warrants. Particularly, put warrants with moneyness between 0.80 and 0.95 are classed into the category of OTM put warrants, and call warrants with moneyness above 0.95 and below 1.05 are grouped into the category of ATM call warrants.

Due to high financial leverage and low transaction cost, informed traders who anticipate negative surprises on firms' monthly revenues prefer to utilize their private information by buying put warrants. Contrarily, informed traders with a long position of call warrants close out their position before negative news shocks arrive at the market. These trades enlarge warrants' IV skew before information arrives in the underlying stock market, leading IV skew to be informative regarding future movements of the underlying stock prices. Taken together, a higher IV skew predicts a drop in future stock prices.

The abnormal IV skew of warrants, $ASkew_{i,[t-2,t-1]}$, is calculated as the difference between the average daily IV skew over the period of $[t-2,t-1]$ and the average of daily IV skew over the period of $[t-60,t-11]$, or:

$$ASkew_{i,[t-2,t-1]} = IVSkew_{i,[t-2,t-1]} - IVSkew_{i,[t-60,t-11]}, \quad (2)$$

and

$$IVSkew_{i,[\tau_1,\tau_2]} = \frac{1}{(\tau_2-\tau_1+1)}\sum_{\tau=\tau_1}^{\tau_2} IVSkew_{i,\tau}, \quad (3)$$

where $IVSkew_{i,[t-2,t-1]}$ and $IVSkew_{i,[t-60,t-11]}$ denote the average daily IV skew over the period of $[t-2,t-1]$ and that of $[t-60,t-11]$, respectively. Similar to the information content embedded in IV skew, a positive value of abnormal IV skew suggests a downward movement in subsequent stock

prices. The method used to measure abnormal IV skew, as we display in Equations (2) and (3), is consistent with that of Zhang (2018).

3.2 Baseline regression specification

We define $CAR_{i,[t,t+1]}$ as the two-day cumulative abnormal return from the monthly-revenue announcement day t to $t+1$, where abnormal return is the daily stock return of firm i in excess of the return on the TAIEX on the same date. To examine the predictability of warrants' IV skew on monthly-revenue announcement return, we regress $CAR_{i,[t,t+1]}$ on abnormal IV skew of warrants and a set of control variables. Specifically, this study tests Hypothesis 1 with the following cross-sectional regressions:

$$CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \sum_{k=1}^{n_k} \gamma_k Control_{i,t}^{k} + \tau_t + u_t + \varepsilon_{i,t+1}, \quad (4)$$

where $Control_{i,t}^{k}$ indicates control variables relevant to abnormal stock return of firm i around monthly-revenue disclosures, and n_k denotes the number of control variables. We include time-fixed effects and industry-fixed effects represented by τ_t and u_t, respectively. The key independent variable in the baseline regression model is the abnormal IV skew of warrants, $ASkew_{i,[t-2,t-1]}$, which is defined and discussed in Section 3.1.

We construct a number of control variables for capturing pre-event stock returns, firm-specific characteristics, and event-specific characteristics. Measures of pre-event stock returns include pre-month stock returns, $Ret_{i,[t-22,t-1]}$, and pre-year stock returns, $Ret_{i,[t-252,t-23]}$, which are the buy-and-hold return compounded from day $t-22$ to $t-1$ and buy-and-hold return compounded from day $t-252$ to $t-23$, respectively. Firm-specific characteristic variables include log market capitalization, intraday volatility, log dividend yield, log market-to-book ratio, log cash-holding ratio, and leverage. We compute the log market capitalization, $Size_{i,t}$, as the natural logarithm of shares outstanding multiplied by the closing price on the event day t. Intraday volatility, $\sigma_{i,[t-20,t-1]}^{intraday}$, is computed by:

$$\sigma_{i,[t-20,t-1]}^{intraday} = \frac{1}{20} \sum_{\tau=t-20}^{t-1} \frac{\left| S_{i,\tau}^{open} - S_{i,\tau}^{closing} \right|}{S_{i,\tau}^{open}}, \quad (5)$$

where $S_{i,\tau}^{open}$ and $S_{i,\tau}^{closing}$ are the opening price and closing price of stock i on day τ. Log

dividend yield, $Ln(DivYld)$, is the natural logarithm of one plus the dividend yield. Log market-to-book ratio, $Ln(MB)$, is the natural logarithm of the market-to-book ratio, where the market-to-book ratio is measured as the market value of equity divided by the book value of equity. Log cash-holding ratio, $Ln(Cash)$, is the natural logarithm of one plus the ratio of cash and short-term investments to total assets. Leverage, $Ln(Debt)$, is defined as the natural logarithm of one plus the debt-to-asset ratio. These control variables are also adopted in Zhang (2018).

This study tests Hypothesis 1 by adopting the regression model specified in Equation (4). Due to the information advantage and preferred trading venue of informed traders, Hypothesis 1 predicts a negative and statistically significant coefficient on abnormal IV skew, indicating that warrants' IV skew possesses the predictive power regarding the abnormal stock return around the successive disclosure of monthly revenues.

3.3 Placebo test

To further confirm that the predictability of IV skew toward monthly-revenue announcement return is attributed to warrant informed trading, rather than from the general predictive power of IV skew in normal periods, this study follows the idea of Zhang (2018) to conduct a placebo test.

We specifically define a fake event date as five trading days leading up to the monthly-revenue announcement date and create a pseudo sample consisting of observations on fake announcement dates. The placebo test is performed by running cross-sectional regressions with a combined sample that pools the pseudo sample and real sample together. The regression specification utilized in the placebo test is:

$$\begin{aligned} CAR_{i,[t,t+1]} = {} & \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{Real} + \beta_3 D_{Real} \\ & + \sum_{k=1}^{n_k} \gamma_k Control_{i,t}^{k} + \tau_t + u_t + \varepsilon_{i,t+1}, \end{aligned} \tag{6}$$

where D_{Real} is a dummy variable setting as:

$$D_{Real} = \begin{cases} 1, & \text{for real announcements of monthly revenues;} \\ 0, & \text{for fake announcements.} \end{cases} \tag{7}$$

Under Hypothesis 1, the coefficient on the interaction term between $ASkew_{i,[t-2,t-1]}$ and D_{Real} should be negative and statistically significant. Additionally, in the case that the predictability of warrants' IV skew is driven by warrant informed trading prior to informational events rather than its persistence in general, the coefficient on the standalone abnormal IV skew in Equation (6) is

insignificant.

3.4 Additional tests

Warrants' IV skew possesses predictive power with respect to monthly-revenue announcement returns when a high proportion of informed investors choose to trade in the warrant market and information conveyed in these trades is disseminated to the stock market afterward. If more informed traders choose to capitalize their private information in the stock market so that information concerning the impending revenue surprises is incorporated into stock prices prior to announcement dates, the information advantage of warrant informed traders diminishes. As a result, the informativeness and predictability of IV skew weaken in response to less informed traders participating in the warrant market and lower information advantage of warrant informed traders.

To assess whether pre-announcement stock returns depress the predictability of warrants' IV skew as suggested in Hypothesis 2, we estimate the following regression equation:

$$\begin{aligned} CAR_{i,[t,t+1]} = {} & \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{\mathrm{Pre}CAR} + \beta_3 D_{\mathrm{Pre}CAR} \\ & + \sum_{k=1}^{n_k} \gamma_k Control_{i,t}^{k} + \tau_t + u_t + \varepsilon_{i,t+1}, \end{aligned} \tag{8}$$

where $D_{\mathrm{Pre}CAR}$ is a dummy variable indicating a positive relation between the pre-announcement abnormal stock return and successive announcement return of stocks. Specifically, $D_{\mathrm{Pre}CAR}$ is set as follows:

$$D_{\mathrm{Pre}CAR} = \begin{cases} 1, & \text{when } CAR_{i,[t-3,t-1]} \times CAR_{i,[t,t+1]} > 0; \\ 0, & \text{when } CAR_{i,[t-3,t-1]} \times CAR_{i,[t,t+1]} \le 0. \end{cases} \tag{9}$$

Here, $CAR_{i,[t-3,t-1]}$ denotes the two-day cumulative abnormal return of stock i from day $t-3$ to $t-1$. Under the setting of $D_{\mathrm{Pre}CAR}$ dummy, the pre-event CAR predicts the subsequent announcement return of stocks when $D_{\mathrm{Pre}CAR}$ dummy takes a value of one.

Hypothesis 2 predicts a negative coefficient on the standalone abnormal IV skew and a positive coefficient on the interaction term between $ASkew_{i,[t-2,t-1]}$ and $D_{\mathrm{Pre}CAR}$. This indicates that the predictability of warrants' IV skew weakens when information about firms' operating revenues is incorporated in their stock prices before public disclosures.

Our next test aims to gauge whether the predictability of warrants' IV skew is asymmetric among good news and bad news on monthly revenues. Traders generally are burdened with a greater

transaction cost and more trading constraints in short selling stocks than buying put warrants. Therefore, the warrant market is more attractive for informed traders participating in bad news. Hypothesis 3 suggests that the informativeness of warrants' IV skew is stronger when the upcoming shock is negative. To test Hypothesis 3, we create a dummy D_{Neg}, which equals unity for announcements of monthly revenue reduction and 0 for announcements of monthly revenue growth, and estimate the following regression:

$$\begin{aligned} CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{Neg} + \beta_3 D_{Neg} \\ + \sum_{k=1}^{n_k} \gamma_k Control_{i,t}^{k} + \tau_t + u_t + \varepsilon_{i,t+1}, \end{aligned} \tag{10}$$

where D_{Neg} is a dummy variable assuming:

$$D_{Neg} = \begin{cases} 1, & \text{for announcements of monthly revenue reduction;} \\ 0, & \text{for announcements of monthly revenue growth.} \end{cases} \tag{11}$$

Under Hypothesis 3, the coefficient on the interaction term between $ASkew_{i,[t-2,t-1]}$ and D_{Neg} is negative and statistically significant.

Due to the property of high financial leverage, the warrant market is more attractive for informed traders with limited funds, especially when they have private information associated with high-priced stocks. Accordingly, Hypothesis 4 suggests that the predictability of warrants' IV skew on monthly-revenue announcement returns is stronger for high-priced stocks than for non-high-priced stocks.

We assess whether the magnitude of stock prices influences the predictability of IV skew by employing the following model:

$$\begin{aligned} CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{Hprice} + \beta_3 D_{Hprice} \\ + \sum_{k=1}^{n_k} \gamma_k Control_{i,t}^{k} + \tau_t + u_t + \varepsilon_{i,t+1}, \end{aligned} \tag{12}$$

where D_{Hprice} is a dummy with a value of unity if the stock price is greater than NT$110.5, which is the sample median of stock prices in the top 20 warranted-stock sample,[5] and zero otherwise. We rank a stock by the amount of warrant contracts that underlie it each year, and the top 20 warranted-stock classes are the 20 most popular. Hypothesis 4 predicts a negative and statistically significant coefficient on the interaction term between abnormal IV skew and the D_{Hprice} dummy.

[5] Please refer to Table 1 that we display in Section 4.2 for more details.

4 Sample description

4.1 Data source

The warrant dataset used in this study is drawn from the Taiwan Economic Journal (TEJ) database, which contains the warrant code, closing price, trading volume, trading value, and implied volatility of warrants listed in the TWSE over the period from January 2014 to July 2022. This warrant dataset also provides information about warrants' characteristics, including warrant type, exercise ratio, listing date, last trading date, units of warrants issued, and exercise price, as well as information concerning the underlying instrument, including security code, closing price, trading volume, and trading value of stocks.

In addition to data on warrants, data on monthly operating performances of listed firms also come from the TEJ database, which consists of the monthly-revenue announcement date and monthly operating revenues for firms listed on the TWSE. Moreover, accounting and balance sheet data for calculating control variables are obtained from the TEJ database as well.

As a remarkable feature of the warrant market, not all individual stocks have warrants issued on them. Specifically, warrant issuers select both the individual stock underlying warrants and the timing of warrant issuances to aim at profit maximization. As a result, a high clustering of warrants can be seen on popular underlying stocks. On the other hand, warrants on neglected stocks generally lack liquidity. To obtain qualifying measurements for warrant informed trading and avoid the possible distortion caused by illiquidity and price discreteness, this study examines the information content of warrant trading with two samples: the top 20 and top 10 warranted-stock samples. We rank a stock by the amount of warrant contracts issued on it each year. Top 20 and top 10 warranted-stock classes are the 20 most and the 10 most popular, respectively.

IV skew for each stock on the announcement date t is calculated based on warrants with a time to maturity greater than 5 days and less than 90 days, a price greater than NT$0.01, and a trading volume greater than 10 contracts. Over the sample period January 2014 through July 2022, the top 20 warranted-stock sample comprises 1,275 monthly-revenue announcements, where each announcing firm has the qualifying measurement of warrants' IV skew on the announcement day, while the top 10 warranted-stock sample contains 687 observations.

4.2 Summary statistics

Table 1 presents descriptive statistics for variables adopted in this study. The average abnormal

stock returns cumulated from the monthly-revenue announcement day t to $t+1$ are -0.176% and -0.274 in the top 20 and top 10 warranted-stock samples, respectively. Average values of abnormal IV skew are 0.002 and 0.005 for the top 20 and top 10 warranted-stock samples, respectively. Overall, these results correspond to the notion that a positive value of abnormal IV skew suggests a subsequently downward movement of stock prices in an average level.

The average value of D_{Neg} dummy is 0.314 in the top 20 warranted-stock sample, indicating that 31.4% of monthly-revenue disclosures are revenue-reduction surprises over the sample period ranging from January 2014 through July 2022, while 68.6% disclosures are revenue-growth surprises. The proportion of revenue-reduction surprises in the top 10 warranted-stock sample is similar. Interesting, $D_{\mathrm{Pre}CAR}$ dummy has average values of 0.477 and 0.463 in our top 20 and top 10 warranted-stock samples, respectively, indicating that no more than 50% of pre-event abnormal stock returns predict the subsequent announcement stock returns.

5 Empirical results

5.1 Baseline regressions analysis

Table 2 reports the estimates from the three models nested in Equation (4), where Panels A and B present the empirical results for the top 20 and top 10 warranted-stock samples, respectively. Model (1) includes abnormal IV skew of warrants as the independent variable. Model (2) is similar to Model (1) and additionally includes two measures of pre-announcement stock return, which are pre-month stock return $Ret_{i,[t-22,t-1]}$ and pre-year stock return $Ret_{i,[t-252,t-23]}$. Model (3) is similar to Model (2), but includes firm-level control variables and industry and year fixed effects. Among these models, Model (3) corresponds to the full baseline regression model displayed in Equation (4).

Table 2 shows that abnormal IV skew of warrants significantly and negatively correlates with cumulative abnormal stock return around the subsequent monthly-revenue announcement for both the top 20 and top 10 warranted-stock samples. This negative relationship between abnormal IV skew and $CAR_{i,[t,t+1]}$ is not only statistically significant across Models (1)-(3), but economically significant. According to the results of Model (3) in Panel B, an increase of one standard deviation in the value of abnormal IV skew (0.137) leads to a decrease in average announcement return by 0.500%, which is 182% of the sample mean of $CAR_{i,[t,t+1]}$.[6] Similarly, for the top 20 warranted-stock sample, the empirical results of Model (3) indicate that an increase of one standard deviation in the value of

[6] Calculated by $0.137\times(-3.65)/(-0.274)=182\%$ for Model 3 of Panel B.

abnormal IV skew (0.119) brings about a reduction in average announcement return by 0.236%. This corresponds to a significant deduction of 134% in the sample's announcement return average.[7]

As we mention above, informed traders with positive/negative information about upcoming disclosures of monthly revenues would buy call/put warrants and close out the long position of put/call warrants, if any, before announcements. These informed trades reduce/enlarge IV skew and lead warrants' IV skew to have capacity in containing information regarding future movements of stock prices. On face appearance, the results in Table 2 suggest that warrants' IV skew predicts the cumulative abnormal stock return surrounding disclosures of monthly revenues, which is in line with the notion of Hypothesis 1. This evidence also corroborates the findings of past studies using a sample of options.

5.2 Empirical analysis for placebo test

We next conduct a placebo test to gauge whether warrants' IV skew predicts the subsequent abnormal stock return only before monthly-revenue announcements or generally in normal periods. This test aims to further address the issue of whether the predictability of IV skew is driven by warrant informed trading. The placebo test is performed by running the cross-sectional regression specified in Equation (6) with a combined sample that pools the pseudo sample and real sample together.

Table 3 displays the results of the placebo test. Interestingly, the coefficient on the interaction term between abnormal IV skew and the D_{Real} dummy is significantly negative at the 1% level across all of the models in Panels A and B. The coefficient on abnormal IV skew standalone is statistically insignificant in most of the models, but turns to be statistically positive at the 10% level in Models (1) and (2) of Panel A. These findings suggest that warrants' IV skew does possess the predictive power regarding abnormal stock return around actual monthly-revenue announcements, but has no predictability in normal periods.

Prior literature including Xing et al. (2010) and Cremers and Weinbaum (2010) documents that options' IV skew predicts future movements of stock prices in general, while Hao (2016) and Zhang (2018) find that the predictability of options' IV skew on successive stock returns exists only before important informational events. The findings in this study are in line with those of Hao (2016) and Zhang (2018). Overall, the evidence found in Table 3 indicates that informed trading is the major driving force behind the warrant market activities prior to monthly-revenue reporting.

[7] Calculated by $0.119\times(-1.98)/(-0.176)=134\%$ for Model 3 of Panel A.

5.3 The moderating influence of pre-event stock returns on the predictability of warrants' IV skew

We next employ the regression model specified in Equation (8) to investigate whether the extent to which information regarding the upcoming disclosures of monthly revenues is reflected in the stock market exerts a moderating influence on the predictability of warrants' IV skew. The results presented in Table 4 are consistent with the main results reported in Table 2, but offer additionally interesting insights. Specifically, the coefficient estimates of abnormal IV skew itself are all negative and significant at the 1% level, and the coefficient of the interaction term between $ASkew_{i,[t-2,t-1]}$ and the D_{PreCAR} dummy is significantly positive at the 5% level across Models (1)-(3) of Panels A and B. These findings suggest that the predictive power of warrants' IV skew weakens when upcoming news about monthly revenues has been reflected by the pre-announcement stock returns, which are consistent with the notion of Hypothesis 2.

We further note that the moderating effect of pre-event stock returns on the predictability of IV skew is pronounced. As reported in Model (3) of Panel A, the sum of the coefficient estimate on $ASkew_{i,[t-2,t-1]}$ and that on the interaction term $ASkew_{i,[t-2,t-1]} \times D_{PreCAR}$ turns to be a positive value of 1.79,[8] indicating that abnormal IV skew has no predictive power regarding successive abnormal return of stocks when unpublished news has already been incorporated into stock prices before monthly-revenue announcements. Similar results are found by Model (3) of Panel B, where the sum of these two coefficient estimates turns to be a positive value of 2.00.[9] This evidence can also be accounted for by Hypothesis 2.

5.4 The asymmetric predictability of warrants' IV skew among positive and negative surprises at firms' operating status

Our next test aims to gauge whether the predictability of warrants' IV skew is asymmetric among good news and bad news on firms' monthly revenues. Table 5 summarizes the estimates from the three models nested in Equation (10), where Panels A and B present the empirical results for the top 20 and top 10 warranted-stock samples, respectively. We first note that the negative coefficient estimates of dummy D_{Neg} across all of the models in Panels A and B correspond with the reaction of stock prices to bad news. For the top 20 warranted-stock sample, the coefficient estimates on the

[8] Calculated by (-3.22) + 5.01 = 1.79 for Model 3 of Panel A.
[9] Calculated by (-4.77) + 6.77 = 2.00 for Model 3 of Panel B.

interaction term $ASkew_{i,[t-2,t-1]} \times D_{Neg}$ are all significantly negative at the 5% level across Models (1)-(3), while most of the coefficient estimates on $ASkew_{i,[t-2,t-1]}$ are negative but insignificant. These findings suggest that IV skew predicts the subsequent announcement return of stocks only when the upcoming shock is negative. Contrarily, the empirical results for the top 10 warranted-stock sample show that most coefficient estimates on $ASkew_{i,[t-2,t-1]}$ and $ASkew_{i,[t-2,t-1]} \times D_{Neg}$ are significantly negative. This empirical evidence indicates that abnormal IV skew has predictive power on the following announcement return of stocks no matter whether the monthly-revenue surprise is positive or negative. Overall, empirical results from both the top 20 and top 10 warranted-stock samples show that the predictability of IV skew is more pronounced when firms disclose a reduction in monthly revenues. These findings are consistent with Hypothesis 3.

5.5 The predictability of warrants' IV skew on monthly-revenue announcement returns of high-priced stocks

We examine whether the magnitude of stock prices influences the predictability of warrants' IV skew by performing a cross-sectional regression specified in Equation (12) and summarize the estimates in Table 6. Remarkably, coefficient estimates of the interaction term $ASkew_{i,[t-2,t-1]} \times D_{Hprice}$ are negative and significant at the 1% significance level throughout Models (1)-(3) of Panels A and B, while none of the coefficient estimates on abnormal IV skew standalone are negative. These findings suggest that warrants' IV skew significantly predicts monthly-revenue announcement returns of high-priced stocks, but has no predictive power for non-high-priced stocks. The salient evidence found in Table 4 is in line with Hypothesis 4, which suggests that the negative relation between IV skew of warrants and CAR around the subsequent monthly-revenue announcement is stronger for high-priced stocks than for non-high-priced stocks.

Our findings are also economically significant. As reported by Model 3 of Table 6, an increase of one standard deviation in abnormal IV skew leads to a reduction in CAR of high-priced stocks by 0.74% and 1.47%[10] for the top 20 and top 10 warranted-stock samples, respectively, which is far greater than the sample mean of $CAR_{i,[t,t+1]}$ and is about 419% and 536% of the sample mean of $CAR_{i,[t,t+1]}$, respectively.[11]

[10] Calculated as $0.119 \times (-6.20) = 0.74\%$ for top 20 warranted-stock sample and $0.137 \times (-10.73) = 1.47\%$ for top 10 warranted-stock sample.

[11] Calculated as 0.119 (-6.20)/(-0.176) = 419% for top 20 warranted-stock sample and 0.137 (-10.73)/(-2.74) = 536% for top 10 warranted-stock sample.

6 Conclusions

This study adopts IV skew as a proxy for informed trading and investigates the information content of warrant informed trading prior to monthly-revenue disclosures in Taiwan accordingly. We find a significantly negative relation between pre-announcement IV skew of warrants and monthly-revenue announcement return of stocks in both the top 20 and top 10 warranted-stock samples. The results of the placebo test show that this predictability exists only before monthly-revenue announcements, rather than persists generally in normal periods, further suggesting the linkage between the predictive power of warrants' IV skew and the information advantage of warrant traders in upcoming disclosures of monthly revenues. These findings corroborate that informed trading is the driving force behind the warrant market activities prior to monthly-revenue reporting.

A set of additional analyses shows that some firm-level and event-level characteristics have impacts on the predictability of warrants' IV skew, including the extent to which the upcoming news is reflected by the pre-event stock returns, negative surprises, or positive surprises at monthly revenues, as well as the magnitude of stock prices. Specifically, the predictability of warrants' IV skew on abnormal stock returns around the subsequent monthly-revenue disclosure is stronger for announcements of revenue reduction, while this predictability weakens when information about impending accounting disclosures has already been incorporated into stock prices prior to monthly-revenue announcements. We also find that only trades on high-priced-stock warrants convey information about abnormal stock return surrounding the following disclosure of monthly revenues. Overall results lead to salient implications that there is clustering by a high proportion of informed traders prior to monthly-revenue disclosures in Taiwan's warrant market, especially on the eve of revenue-reduction surprises or before monthly-revenue disclosures of high-priced-stock firms. Contrarily, no predictability of warrant informed trading is found when upcoming news about firms' monthly revenues is reflected by pre-announcement stock returns.

Reference

Atilgan, Y. (2014). Volatility spreads and earnings announcement returns. *Journal of Banking & Finance*, 38, 205-215.

Bali, T. G., & Murray, S. (2013). Does risk-neutral skewness predict the cross section of equity option portfolio returns? *Journal of Financial and Quantitative Analysis*, 48, 1145-1171.

Beaver, W. H., McNichols, M. F., & Wang, Z. Z. (2018). The information content of earnings announcements: new insights from intertemporal and cross-sectional behavior. *Review of Accounting Studies*, 23, 95-135.

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

Chan, K., Chung, Y., & Fong, W. (2002). The informational role of stock and option volume. *Review of Financial Studies*, 15, 1049–1075.

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

Chan, Y. -C., & Wei, K. C. J. (2001). Price and volume effects associated with derivative warrant issuance on the Stock Exchange of Hong Kong. *Journal of Banking & Finance*, 25, 1401-1426.

Chang, E. C., Luo, X., Shi, L., & Zhang, J. E. (2013). Is warrant really a derivative? Evidence from the Chinese warrant market. *Journal of Financial Markets*, 16, 165-193.

Chen, W. -D., & Yu, C. -T. (2022). The information value of interim accounting disclosures: Evidence from mandatory monthly revenue reports. *Review of Quantitative Finance and Accounting*, 58, 245-295.

Chen, H. -Y., Chen, S. -S., Hsin, C. -W., & Lee, C. -F. (2014). Does revenue momentum drive or ride earnings or price momentum? *Journal of Banking & Finance*, 38, 166-185.

Chiang, R., & Fung, W. (2001). Relative informational efficiency of cash, futures, and option markets: The case of an emerging market. *Journal of Banking and Finance*, 25, 355-375.

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

Ertimur, Y., Livnat, J., & Martikainen, M. (2003). Differential market reactions to revenue and expense surprises. *Review of Accounting Studies*, 8, 185-211.

Gharghori, P., Maberly, E. D., & Nguyen, A. (2017). Informed trading around stock split announcements: Evidence from the option market. *Journal of Financial and Quantitative Analysis,* 50, 705-735.

Hao, Q. (2016). Is there information leakage prior to share repurchase announcements? Evidence from daily options trading. *Journal of Financial Markets*, 27, 79–101.

Jayaraman, N., Frye, M., & Sabherwal, S. (2001). Informed trading around merger announcements: An empirical test using transaction volume and open interest in options market. *Financial Review,* 36, 45-74.

Jin, W., Livnat, J., & Zhang, Y. (2012). Option prices leading equity prices: Do option traders have an information advantage? *Journal of Accounting Research,* 50, 401-431.

Kim, O., Lim, S. C., & Park, T. (2009). Measuring the impact of sales on earnings and equity price. *Review of Quantitative Finance and Accounting*, 32, 145-168.

Tang, K., & Wang, C. (2013). Are Chinese warrants derivatives? Evidence from connections to their underlying stocks. *Quantitative Finance*, 13, 1225-1240.

Xing, Y., Zhang, X., & Zhao, R. (2010). What does the individual option volatility smirk tell us about future equity returns? *Journal of Financial and Quantitative Analysis,* 45, 641-662.

Xiong, W., & Yu, J. (2011). The Chinese warrants bubble. *American Economic Review*, 101, 2723-2753.

Zhang, J. (2018). Informed options trading prior to dividend change announcements. *Financial Management*, 47, 81-103.

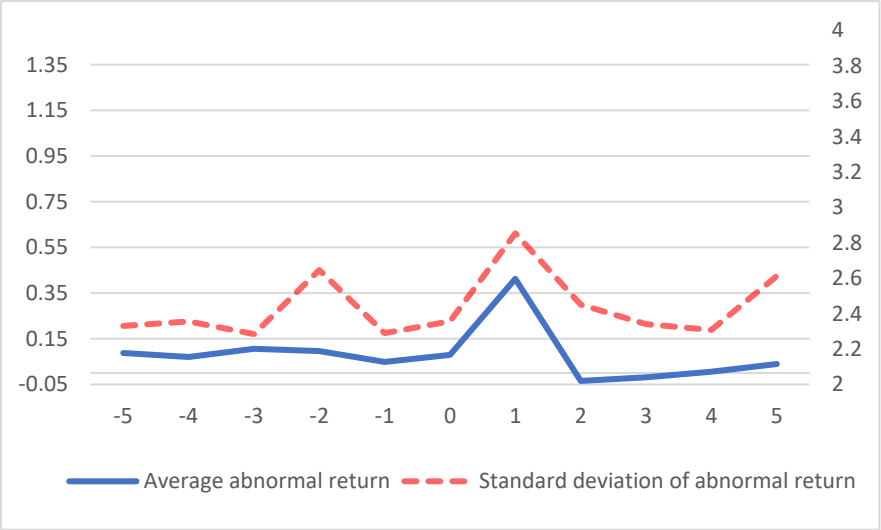

Figure 1. Daily evolution of average abnormal stock returns around monthly-revenue disclosures performed by firms with year-over-year growth in monthly revenues

The figure depicts the average and standard deviation of abnormal stock return for monthly-revenue-growth disclosures in the top 20 warranted-stock sample over the [−5, +5] event window. Abnormal return is measured as daily stock return in excess of the TAIEX return on the same date, and day 0 is the monthly-revenue announcement date. The sample period ranges from January 2014 through July 2022.

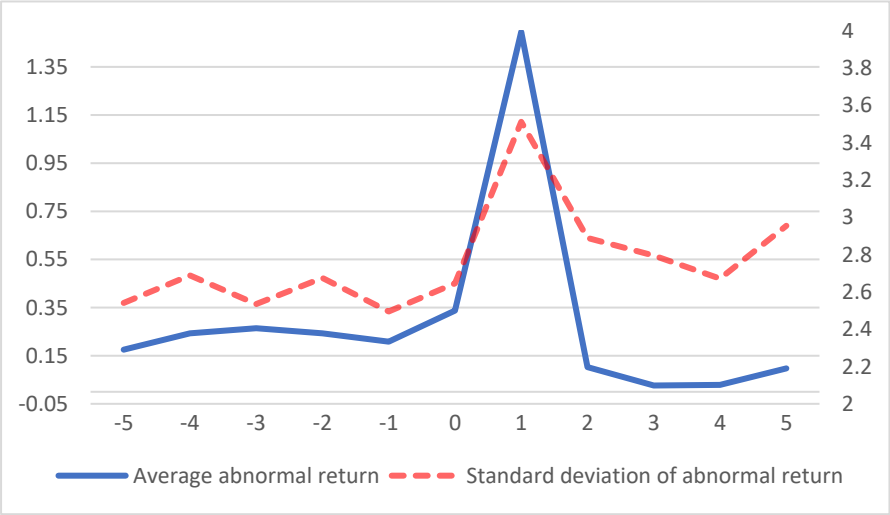

Figure 2. Daily evolution of average abnormal stock returns around monthly-revenue disclosures performed by firms with monthly revenues hitting a record high

The figure depicts the average and standard deviation of abnormal stock return for disclosures of record-high monthly revenues in the top 20 warranted-stock sample over the [−5, +5] event window. Abnormal return is measured as daily stock return in excess of the TAIEX return on the same date, and day 0 is the monthly-revenue announcement date. The sample period ranges from January 2014 through July 2022.

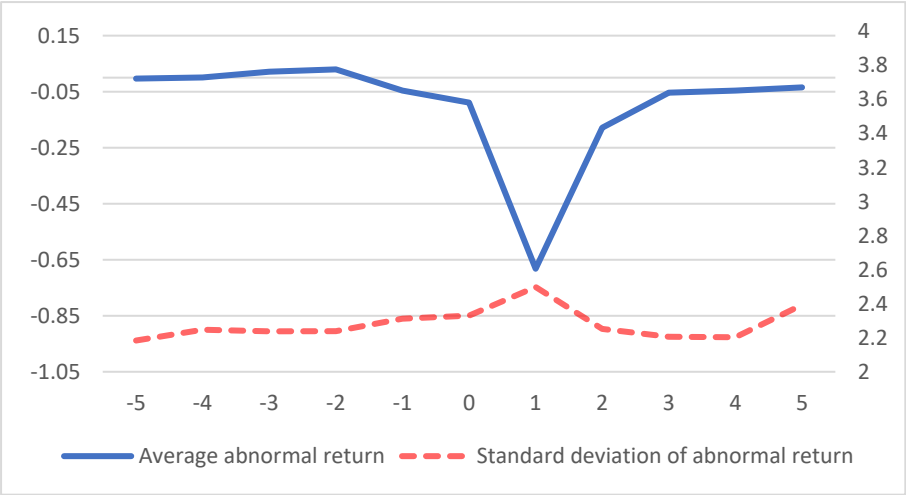

Figure 3. Daily evolution of average abnormal stock returns around monthly-revenue disclosures performed by firms with year-over-year decline in monthly revenues

The figure depicts the average and standard deviation of abnormal stock return for monthly-revenue-reduction disclosures in the top 20 warranted-stock sample over the [−5, +5] event window. Abnormal return is measured as daily stock return in excess of the TAIEX return on the same date, and day 0 is the monthly-revenue announcement date. The sample period ranges from January 2014 through July 2022.

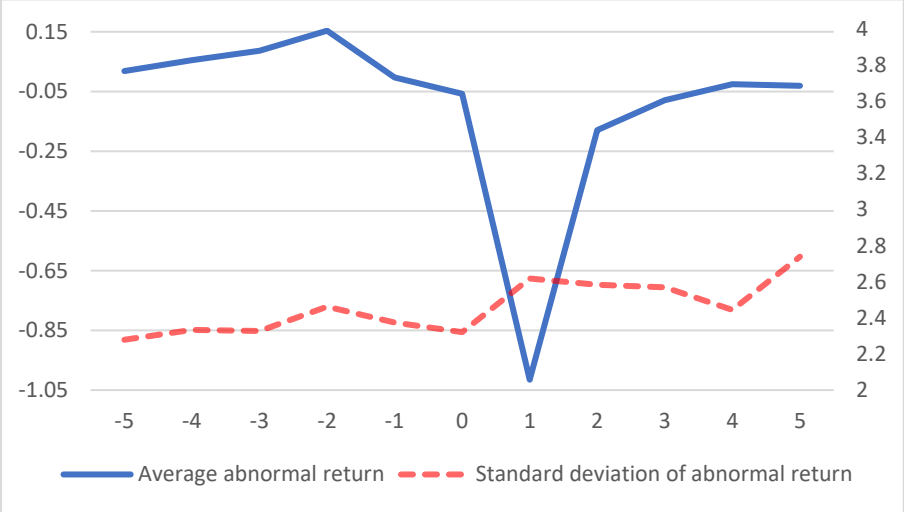

Figure 4 Daily evolution of average abnormal stock returns around monthly-revenue disclosures performed by firms with monthly revenues hitting a record low

The figure depicts the average and standard deviation of abnormal stock return for disclosures of record-low monthly revenues in the top 20 warranted-stock sample over the [−5, +5] event window. Abnormal return is measured as daily stock return in excess of the TAIEX return on the same date, and day 0 is the monthly-revenue announcement date. The sample period ranges from January 2014 through July 2022.

Table 1 Descriptive statistics

Variable	Mean	Std. Dev.	5%-ile	25%-ile	Median	75%-ile	95%-ile
Panel A. Top 20 warranted stocks							
$ASkew_{i,[t-2,t-1]}$	0.002	0.119	-0.099	-0.021	0.001	0.023	0.083
$CAR_{i,[t,t+1]}$	-0.176	3.650	-6.314	-2.005	-0.183	1.638	5.872
$Ret_{i,[t-22,t-1]}$	1.153	11.748	-18.303	-5.594	1.162	8.325	19.114
$Ret_{i,[t-252,t-23]}$	18.536	51.230	-61.384	-13.904	18.465	44.813	104.910
$Size_{i,t}$	12.108	1.431	10.263	11.046	11.769	12.971	15.112
$\sigma^{intraday}_{i,[t-20,t-1]}$	0.016	0.007	0.007	0.011	0.015	0.020	0.030
$Ln(DivYld)$	0.032	0.024	0.000	0.017	0.031	0.044	0.067
$Ln(MB)$	0.753	0.735	-0.416	0.270	0.647	1.275	2.048
$Ln(Cash)$	0.205	0.100	0.062	0.128	0.193	0.266	0.401
$Ln(Debt)$	0.380	0.116	0.184	0.294	0.398	0.456	0.546
D_{PreCAR}	0.477	0.500	0.000	0.000	0.000	1.000	1.000
D_{Neg}	0.314	0.464	0.000	0.000	0.000	1.000	1.000
D_{Hprice}	0.504	0.500	0.000	0.000	1.000	1.000	1.000
$S^{closing}_{i,t}$	290.156	682.462	13.050	48.300	110.500	253.500	851.000
Panel B. Top 10 warranted stocks							
$ASkew_{i,[t-2,t-1]}$	0.005	0.137	-0.089	-0.019	0.001	0.020	0.075
$CAR_{i,[t,t+1]}$	-0.274	3.625	-6.338	-2.038	-0.253	1.449	5.221
$Ret_{i,[t-22,t-1]}$	0.690	11.637	-19.618	-5.695	0.560	8.133	18.716
$Ret_{i,[t-252,t-23]}$	12. 927	52.975	-71.317	-20.785	12.995	39.259	105.642
$Size_{i,t}$	12.689	1.521	10.708	11.445	12.404	13.795	15.558
$\sigma^{intraday}_{i,[t-20,t-1]}$	0.015	0.007	0.006	0.010	0.014	0.020	0.029
$Ln(DivYld)$	0.033	0.026	0.000	0.018	0.030	0.041	0.078
$Ln(MB)$	0.750	0.727	-0.462	0.285	0.683	1.258	2.006
$Ln(Cash)$	0.228	0.102	0.069	0.161	0.223	0.286	0.444
$Ln(Debt)$	0.359	0.098	0.192	0.285	0.349	0.441	0.521
D_{PreCAR}	0.463	0.499	0.000	0.000	0.000	1.000	1.000
D_{Neg}	0.354	0.478	0.000	0.000	1.000	1.000	1.000
D_{Hprice}	0.639	0.481	-0.934	-0.355	-0.016	0.266	1.119
$S^{closing}_{i,t}$	438.162	897.823	13.350	81.300	184.000	323.5	2615.000

Notes: This table reports summary statistics of warrant trading variables, firm-specific characteristic variables, and event-specific characteristic variables contained in our dataset over the sample period ranging from January 2014 to July 2022. Time t is the monthly-revenue announcement day on which a qualifying measurement for warrant informed trading is available. $ASkew_{i,[t-2,t-1]}$ represents abnormal IV skew of warrants, defined as the average IV skew over $[t-2,t-1]$ minus the average IV skew over $[t-60,t-11]$. $CAR_{i,[t,t+1]}$ denotes the two-day cumulative abnormal return of stock i from the announcement day t to $t+1$, in which the abnormal return is measured as daily return of stock i in excess of the TAIEX return on the same date. We rank a stock by the amount of warrant contracts that underlie it each year. Top 20 and Top 10 warranted-stock classes are the top 20 and the top 10 most popular, respectively.

Table 2 Regression results for the impact of warrants' IV skew on monthly-revenue announcement returns of stocks during the period January 2014 through July 2022

Dependent variable	(1)	(2)	(3)	(1)	(2)	(3)
	Panel A. Top 20 warranted stocks			Panel B. Top 10 warranted stocks		
Intercept	-0.17* (-1.69)	-0.27** (-2.54)	-0.56 (-0.31)	-0.26* (-1.90)	-0.33** (-2.33)	0.55 (0.19)
$ASkew_{i,[t-2,t-1]}$	-1.61* (-1.88)	-1.83** (-2.14)	-1.98** (-2.28)	-2.42** (-2.40)	-2.76*** (-2.73)	-3.65*** (-3.31)
$Ret_{i,[t-22,t-1]}$		0.02*** (2.60)	0.02** (2.07)		0.03** (2.26)	0.02 (1.37)
$Ret_{i,[t-252,t-23]}$		0.00** (2.11)	0.01** (2.17)		0.00 (1.49)	0.00 (0.51)
$Size_{i,t}$			0.02 (0.21)			0.02 (0.10)
$\sigma^{intraday}_{i,[t-20,t-1]}$			-30.26 (-1.51)			-25.41 (-0.85)
$Ln(DivYld)$			-3.51 (-0.66)			-13.41* (-1.66)
$Ln(MB)$			0.07 (0.33)			-0.08 (-0.25)
$Ln(Cash)$			-0.23 (-0.18)			-0.83 (-0.43)
$Ln(Debt)$			2.17* (1.69)			1.56 (0.78)
Year and industry dummies			Y			Y
N	1,275	1,275	1,275	687	687	687
Adj R^2	0.0020	0.0092	0.0189	0.0069	0.0146	0.0348

Notes: (1) The regression specification underlying the results reported in this table is:

$$CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \sum_{k=1}^{n_k} \gamma_k Control^k_{i,t} + \tau_t + u_t + \varepsilon_{i,t+1}, \quad (4)$$

where $CAR_{i,[t,t+1]}$ denotes the cumulative abnormal return of stock i over the monthly-revenue announcement day t to $t+1$, $ASkew_{i,[t-2,t-1]}$ is abnormal IV skew of warrants, and $Control^k_{i,t}$ indicates control variables relevant for the cumulative abnormal return of stock i. (2) Panel A contains the results for the cumulative abnormal return of the top 20 warranted stocks, and Panel B represents the results for the cumulative abnormal return of the top 10 warranted stocks. (3) The sample period ranges from January 2014 to July 2022. (4) The values reported in parentheses are t-statistics. (5) One, two, and three asterisks indicate the 10%, 5%, and 1% significance levels, respectively.

Table 3 Regressions of warrants' IV skew on monthly-revenue announcement returns of stocks with the combined sample pooling real and fake announcements together

Dependent variable	(1)	(2)	(3)	(1)	(2)	(3)
	Panel A. Top 20 warranted stocks			Panel B. Top 10 warranted stocks		
Intercept	0.18* (1.90)	0.10 (1.03)	0.37 (0.31)	0.19 (1.48)	0.11 (0.86)	1.95 (1.06)
$ASkew_{i,[t-2,t-1]}$	1.39* (1.87)	1.34* (1.81)	1.17 (1.56)	2.02 (1.52)	1.80 (1.36)	1.05 (0.77)
$ASkew_{i,[t-2,t-1]} \times D_{Real}$	-3.00*** (-2.75)	-3.06*** (-2.80)	-3.05*** (-2.79)	-4.44*** (-2.74)	-4.53*** (-2.81)	-4.35*** (-2.70)
D_{Real}	-0.35*** (-2.63)	-0.35*** (-2.62)	-0.37*** (-2.77)	-0.45** (-2.50)	-0.44** (-2.44)	-0.44** (-2.48)
$Ret_{i,[t-22,t-1]}$		0.01 (1.08)	0.00 (0.80)		0.02*** (3.04)	0.02** (2.09)
$Ret_{i,[t-252,t-23]}$		0.00*** (2.99)	0.00** (2.24)		0.00** (2.29)	0.00 (0.73)
$Size_{i,t}$			0.01 (0.14)			-0.02 (-0.18)
$\sigma_{i,[t-20,t-1]}^{intraday}$			-15.59 (-1.17)			-11.03 (-0.56)
$Ln(DivYld)$			4.58 (1.31)			-4.04 (-0.77)
$Ln(MB)$			0.04 (0.28)			-0.22 (-1.08)
$Ln(Cash)$			-0.89 (-1.02)			-0.70 (-0.55)
$Ln(Debt)$			0.19 (0.23)			-1.03 (-0.79)
Year and industry dummies			Y			Y
N	2,552	2,552	2,552	1,375	1,375	1,375
Adj R^2	0.0045	0.0077	0.0131	0.0091	0.0180	0.0296

Notes: (1) This table presents regression results estimated by pooling the real and pseudo samples together. The regression specification is:

$$CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{Real} + \beta_3 D_{Real} + \sum_{k=1}^{n_k} \gamma_k Control_{i,t}^{k} + \tau_t + u_t + \varepsilon_{i,t+1}, \quad (6)$$

where $CAR_{i,[t,t+1]}$ denotes the cumulative abnormal return of stock i over the monthly-revenue announcement day t to $t+1$, $ASkew_{i,[t-2,t-1]}$ is abnormal IV skew of warrants, $Control_{i,t}^{k}$ indicates control variables relevant for the cumulative abnormal return of stock i, and D_{Real} is a dummy variable indicating real announcements of monthly revenues. (2) The sample period ranges from January 2014 to July 2022. (3) The t-statistics are in parentheses. (4) One, two, and three asterisks denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4 The moderating influence of pre-announcement stock returns on the predictability of warrants' IV skew

Dependent variable	(1)	(2)	(3)	(1)	(2)	(3)
	Panel A. Top 20 warranted stocks			Panel B. Top 10 warranted stocks		
Intercept	-0.14 (-1.00)	-0.23 (-1.62)	-0.72 (-0.40)	-0.09 (-0.47)	-0.15 (-0.77)	0.78 (0.28)
$ASkew_{i,[t-2,t-1]}$	-2.84*** (-2.85)	-3.14*** (-3.16)	-3.29*** (-3.27)	-3.30*** (-3.04)	-3.70*** (-3.40)	-4.77*** (-4.02)
$ASkew_{i,[t-2,t-1]} \times D_{PreCAR}$	4.71** (2.41)	5.02** (2.57)	5.01** (2.55)	5.81** (2.00)	6.13** (2.11)	6.77** (2.31)
$D_{\mathrm{Pre}CAR}$	-0.56 (-0.29)	-0.10 (-0.47)	-0.09 (-0.46)	-0.36 (-1.28)	-0.39 (-0.42)	-0.40 (-1.44)
$Ret_{i,[t-22,t-1]}$		0.02*** (2.60)	0.02** (2.05)		0.03** (2.27)	0.02 (1.31)
$Ret_{i,[t-252,t-23]}$		0.00** (2.31)	0.01** (2.32)		0.00* (1.73)	0.00 (0.61)
$Size_{i,t}$			0.04 (0.34)			0.02 (0.11)
$\sigma^{intraday}_{i,[t-20,t-1]}$			-29.62 (-1.48)			-24.10 (-0.81)
$Ln(DivYld)$			-3.73 (-0.70)			-14.68* (-1.82)
$Ln(MB)$			0.05 (0.27)			-0.09 (-0.30)
$Ln(Cash)$			-0.31 (-0.23)			-0.94 (-0.49)
$Ln(Debt)$			2.24* (1.75)			1.61 (0.81)
Year and industry dummies			Y			Y
N	1,275	1,275	1,275	687	687	687
Adj R^2	0.0050	0.0129	0.0226	0.0122	0.0210	0.0426

Notes: (1) This table presents the coefficients from the regression:

$$CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{\mathrm{Pre}CAR} + \beta_3 D_{\mathrm{Pre}CAR} + \sum_{k=1}^{n_k} \gamma_k Control^k_{i,t} + \tau_t + u_t + \varepsilon_{i,t+1}, \quad (8)$$

where $CAR_{i,[t,t+1]}$ denotes the cumulative abnormal return of stock i over the monthly-revenue announcement day t to $t+1$, $ASkew_{i,[t-2,t-1]}$ is abnormal IV skew of warrants, $Control^k_{i,t}$ indicates control variables relevant for the cumulative abnormal return of stock i, and $D_{\mathrm{Pre}CAR}$ is a dummy variable indicating a positive relation between the pre-announcement CAR and subsequent announcement return of stocks. (2) The sample period ranges from January 2014 to July 2022. (3) The values reported in parentheses are t-statistics. (4) One, two, and three asterisks indicate the 10%, 5%, and 1% significance levels, respectively.

Table 5 The asymmetric predictability of warrants' IV skew among positive surprises and negative surprises at firms' operating status

Dependent variable	(1)	(2)	(3)	(1)	(2)	(3)
	Panel A. Top 20 warranted stocks			Panel B. Top 10 warranted stocks		
Intercept	0.13 (1.03)	0.07 (0.50)	-0.89 (-0.50)	0.15 (0.86)	0.18 (0.93)	0.85 (0.30)
$ASkew_{i,[t-2,t-1]}$	-1.23 (-1.40)	-1.37 (-1.56)	-1.50* (-1.68)	-2.20** (-2.16)	-2.34** (-2.28)	-3.16*** (-2.81)
$ASkew_{i,[t-2,t-1]} \times D_{Neg}$	-8.26** (-2.14)	-8.32** (-2.16)	-8.98** (-2.31)	-7.99 (-1.64)	-8.01* (-1.65)	-8.55* (-1.74)
D_{Neg}	-0.95*** (-4.37)	-0.89*** (-3.67)	-0.90*** (-3.50)	-1.16*** (-4.09)	-1.24*** (-3.76)	-1.13*** (-3.19)
$Ret_{i,[t-22,t-1]}$		0.02** (2.35)	0.02* (1.77)		0.02** (2.04)	0.01 (1.16)
$Ret_{i,[t-252,t-23]}$		0.00 (0.26)	0.00 (1.09)		-0.00 (-0.64)	-0.00 (-0.55)
$Size_{i,t}$			0.05 (0.47)			0.01 (0.07)
$\sigma^{intraday}_{i,[t-20,t-1]}$			-21.92 (-1.06)			-20.18 (-0.68)
$Ln(DivYld)$			-3.29 (-0.62)			-11.33 (-1.41)
$Ln(MB)$			-0.11 (-0.57)			-0.21 (-0.66)
$Ln(Cash)$			0.39 (0.30)			-0.87 (-0.45)
$Ln(Debt)$			2.04 (1.60)			1.22 (0.61)
Year and industry dummies			Y			Y
N	1,275	1,275	1,275	687	687	687
Adj R^2	0.0188	0.0216	0.0307	0.0314	0.0352	0.0503

Notes: (1) The regression specification underlying the results reported in this table is:

$$CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{Neg} + \beta_3 D_{Neg} + \sum_{k=1}^{n_k} \gamma_k Control^k_{i,t} + \tau_t + u_t + \varepsilon_{i,t+1}, \quad (10)$$

where $CAR_{i,[t,t+1]}$ denotes the cumulative abnormal return of stock i over the monthly-revenue announcement day t to $t+1$, $ASkew_{i,[t-2,t-1]}$ is abnormal IV skew of warrants, $Control^k_{i,t}$ indicates control variables relevant for the cumulative abnormal return of stock i, and D_{Neg} is a dummy variable indicating that firms report a year-over-year decrease in monthly revenues. (2) The sample period ranges from January 2014 to July 2022. (3) The values reported in parentheses are t-statistics. (4) One, two, and three asterisks indicate the 10%, 5%, and 1% significance levels, respectively.

Table 6 The predictability of warrants' IV skew on monthly-revenue announcement returns of high-priced stocks

Dependent variable	(1)	(2)	(3)	(1)	(2)	(3)
	Panel A. Top 20 warranted stocks			Panel B. Top 10 warranted stocks		
Intercept	-0.13 (-0.87)	-0.23 (-1.56)	0.09 (0.05)	-0.17 (-0.76)	-0.23 (-1.01)	0.68 (0.24)
$ASkew_{i,[t-2,t-1]}$	2.39 (1.43)	2.50 (1.50)	2.47 (1.47)	5.23** (2.09)	5.51** (2.20)	5.20** (2.05)
$ASkew_{i,[t-2,t-1]} \times D_{Hprice}$	-5.42*** (-2.79)	-5.87*** (-3.02)	-6.20*** (-3.15)	-9.09*** (-3.32)	-9.86*** (-3.59)	-10.73*** (-3.88)
D_{Hprice}	-0.08 (-0.37)	-0.09 (-0.44)	0.14 (0.45)	-0.11 (-0.37)	-0.14 (-0.50)	0.26 (0.61)
$Ret_{i,[t-22,t-1]}$		0.02*** (2.68)	0.02** (2.19)		0.03** (2.30)	0.02** (1.32)
$Ret_{i,[t-252,t-23]}$		0.00** (2.33)	0.01** (2.34)		0.01** (1.99)	0.00** (0.91)
$Size_{i,t}$			-0.00 (-0.02)			0.03 (0.19)
$\sigma^{intraday}_{i,[t-20,t-1]}$			-32.98* (-1.65)			-28.54 (-0.96)
$Ln(DivYld)$			-5.19 (-0.99)			-15.03 (-1.87)
$Ln(MB)$			-0.01 (-0.03)			-0.27 (-0.72)
$Ln(Cash)$			-0.51 (-0.39)			-1.43 (-0.74)
$Ln(Debt)$			1.49 (1.26)			1.04 (0.50)
Year and industry dummies			Y			Y
N	1,275	1,275	1,275	687	687	687
Adj R^2	0.0066	0.0149	0.0261	0.0200	0.0303	0.0552

Notes: (1) This table presents the coefficients from the regression:

$$CAR_{i,[t,t+1]} = \alpha_0 + \beta_1 ASkew_{i,[t-2,t-1]} + \beta_2 ASkew_{i,[t-2,t-1]} \times D_{Hprice} + \beta_3 D_{Hprice} + \sum_{k=1}^{n_k} \gamma_k Control^k_{i,t} + \tau_t + u_t + \varepsilon_{i,t+1}, \quad (12)$$

where $CAR_{i,[t,t+1]}$ denotes the cumulative abnormal return of stock i over the monthly-revenue announcement day t to $t+1$, $ASkew_{i,[t-2,t-1]}$ is abnormal IV skew of warrants, $Control^k_{i,t}$ indicates control variables relevant for the cumulative abnormal return of stock i, and D_{Hprice} is a dummy variable, which equals unity if the stock price is greater than NT$110.5 and zero otherwise. (2) The sample period ranges from January 2014 to July 2022. (3) The values reported in parentheses are t-statistics. (4) One, two, and three asterisks indicate the 10%, 5%, and 1% significance levels, respectively.