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Disposition, Confidence, and Profits and Losses: Evidence from the Taiwan Warrant Markets

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Keywords

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Abstract.

In this paper, we first examine the extent that a warrant's characteristics, i.e., size of the underlying stock, effective leverage, time value, and implied volatility, affect behavioral measures, i.e., coefficients of disposition and coefficients of confidence, of two types of investors, i.e., individual investors and dealers, in the Taiwan warrant markets. Second, we explore the impacts of coefficients of disposition and coefficients of confidence on profits and losses (PL) by separate groups of investors. Finally, we find that cross-market spillover effects on levels of disposition coefficients and levels of confidence of individual investors from spot markets are especially important to contribute to PL of individual investors and dealers. Accordingly, our novel discoveries shed some light on better understanding of investors' behavioral biases.

1. Introduction

Ever since Kahneman and Tverskey [30] propose the Prospect theory to challenge the assumptions on rational behaviors in traditional finance, a great deal of empirical studies have put forward evidence to confirm the existence of abnormal behaviors, e.g., disposition effects, overconfidence, and herding. In particular, disposition effects and overconfidence attract much attention from researchers.

Shefrin and Statman [42] propose that disposition effects are the phenomena that investors tend to hold losers and sell winners because they are apt to be hesitant to sell underperforming stocks to realize their paper losses, and subsequent studies confirm such biases (see e.g., Odean [39]; Weber and Camerer, [45]; Grinblatt and Keloharju [29]; Garvey and Murphy [27]; Barber et al. [4]; Barber et al.[5]; Li et al. [37]). On the other hand, overconfidence leads investors to overestimate their knowledge and abilities

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on investing (Daniel et al. [18]; Odean [40]). In particular, these behavioral biases are likely to lead investors to trade based on their prior returns with excessive trading, and may further cause markets more volatile.

Most extant literature investigates the existence of such investors' behavioral biases in stock markets (see e.g., Odean [41]; Barber and Odean [6]; Barber and Odean [7], and Barber and Odean [8] *inter alia*) and futures markets (see e.g., Chou and Wang [16]; Kuo and Lin [35]; Li et al. [37]), and whether these behavioral biases can explain market anomalies and the relations among returns, volume and volatility. In contrast, Abreu [1] examines whether the characteristics of investors are associated with trading behaviors in Portuguese warrant markets by using a socio-demographic dataset, and finds that investors with overconfidence, disposition effects and gambling attitudes tend to have higher propensity to participate in trading warrants. In addition, investors who pursue entertaining effect incline to trade complicated financial instruments more than to trade those easy to understand.

Warrants are originally designed for investors with less capital who are interested in gaining short-term price spread of listed stocks. Investors have advantages in trading warrants than trading listed stocks, such as lower premiums, lower trading restrictions, higher leverages, limited losses, and lower transaction costs in Taiwan. Accordingly, dealers might issue warrants with diverse contract specifications on identical underlying assets to meet the trading demands of investors. For example, warrants with lower exercise ratio for higher-priced stocks enable individual investors with limited capital to trade them, and put warrants allow individual investors to have short positions by limited premium instead of a huge margin.

Accordingly, our study has the following findings and significant contributions to the extant literature. First, we explore levels of confidence and levels of disposition of individual investors and dealers by using the detailed transaction data of Taiwan's warrant markets from the Taiwan Stock Exchange (TWSE). The dataset allows us to identify each transaction made by different investor types, which facilitates better understanding about the trading behaviors of individual investors and dealers in the warrant markets. In particular, we find that both individual investors and dealers tend to realize their profits, and to be less confident on the warrants whose underlying stocks in smaller scale, indicating that transparency and information asymmetry are likely to influence individual investor and dealers' behaviors. In particular, there are positive linkages with cross-market spillover effects on levels of disposition coefficients and level of confidence between spot markets and their corresponding warrant markets. Second, we explore the impacts of coefficients of disposition and coefficients of confidence on the profits and losses (PL) of individual investors and dealers on warrant markets. Although coefficients of disposition and coefficients of confidence on warrant markets have considerable impacts on PL by separate groups of investors, cross-market spillover effects on levels of disposition and levels of confidence of individual investors from spot markets are especially important to contribute to PL of individual investors and dealers. Our results are important because they shed light on how a warrant's characteristics affect coefficients of disposition and coefficients of confidence, and how these coefficients affect PL.

The remainder of this paper is organized as follows. Section 2 discusses the phenomena of overconfidence and disposition effects in behavioral finance; Section 3 introduces the institutional background and the data from the TWSE; Section 4 presents our methodology and empirical findings; Section 5 reexamines the results and conducts the robustness analysis; and Section 6 summarizes the results and concludes.

2. Overconfidence and Disposition Effects

Over decades, the Efficient Market Hypothesis (EMH) has been one of the mainstreams in finance since Fama [22] hypothesizes that market price can reflect all available information in a market with strong form of market efficiency, in which market price is an unbiased estimate of asset value. However, behavioral finance has gradually received attention from academicians and practitioners since 1980. In particular, many abnormal phenomena that cannot be explained by traditional finance theories have therefore challenged EMH. Theoretically, Kahneman and Tverskey [30] point out that traditional utility theory cannot fully explain the behaviors of investors under uncertain circumstances, and propose Prospect Theory to explain the phenomena that traditional utility theory fails to explain. As a result, many studies apply the theoretical framework to examine the abnormalities in financial markets. For example, Odean [40] finds that overconfident traders cannot share the risk in the best way and are engaged in information acquisition and trade frequently, making them at a loss. In addition, Barber and Odean [7] demonstrate that the average turnover rate of male investors is 1.45 times that of female investors, but the excess transactions reduce the net return rate of male investors by 2.65investors.) Also, Shu et al. [43] find that male investors trade more excessively than female investors from a renowned brokerage house in Taiwan. On the other hand, Ben-David and Doukas [10] indicate that the transaction frequency of institutional investors is due to overconfidence, and there is an asymmetric effect on the past trading performance between winners and losers. Chuang and Susmel [17] point out that individual investors are more likely to be overconfident than institutional investors. Kuo and Lin [35] demonstrate that day traders' transactions lead to significant losses, and conclude that day traders are overconfident in the Taiwan futures markets.

In contrast to overconfidence, Shefrin and Statman [42] state that disposition effects are the phenomena that investors tend to realize the profits of their winner stocks too early, but hold their looser stocks too long. Weber and Camerer [45] conclude that disposition effects may be due to investors' attitudes towards risk, i.e., they are relatively risk-averse on profits, while relatively risk-taking on losses. Chen et al. [15] demonstrate that disposition effects are significant for Chinese investors. In addition, they also find that experienced investors are not always better than inexperienced investors in China. Frazzini [24] summarizes that disposition effects lead to price under reaction because the security prices depend on the reference prices of investors and the information content of news. Interestingly, Shu et al. [44] find that Taiwanese investors are more prone to have disposition effects than investors in the U.S. On the other hand, Nolte [38] draws a different shape on disposition effects, i.e., investors tend to have an inverted disposition effect for smaller profits and losses, while the usual positive disposition effects emerge for larger profits and losses. Li et al. [37] conclude that disposition effects exist both in individuals and foreign institutions, but not in dealers, and foreign institutions with weaker disposition effects outperform individuals. In particular, Abreu [1] investigates the investor profile from one of the top three banks in Portugal, and finds that young men with lower education levels are more likely to invest in warrants, and overconfident investors incline to show their gambling attitude. In addition, gambling seems to be a distinctive feature of warrant investors. In other words, for those investors who trade for entertainment in financial markets, they tend to trade more complex products in simple strategies. Moreover, the higher the intensity of the trading, the more relevant the disposition effects and the prejudice of gamblers. In this paper, instead of examinations of overconfidence and disposition effects, we investigate the behaviors of individual investors and dealers by using the levels of disposition and the levels of confidence, respectively. Such approach let us not only explore the impacts of a warrant's characteristics on the levels of disposition and the levels of confidence, but also discuss the impacts of the levels of disposition and the levels of confidence on PL of individual investors and dealers, respectively.

3. Institutional Background and the Data from the TWSE

With its huge volume and turnover rate of stock trading in Asia, the Taiwan Stock Exchange (TWSE) has launched its first warrant in 1997. According to the World Federation of Exchanges (WFE) Statistics, TWSE is the 2nd largest Asian warrant market with 26,681 traded warrants and 22.58 billion USD trading value, and the trading volume is 658,103,787 lots at the end of 2014. Individual investors and institutional investors, including mutual funds, foreign institutions, and dealers all play significant roles in the stock markets of the TWSE, i.e., individual investors account for 58.49% of the trading and foreign institutions and domestic institutions, including mutual funds and dealers, account for 23.76% and 17.75% of the trading value, respectively. However, in addition to dealers, who are the issuers of warrants, almost no mutual funds and foreign institutions trade warrants on the TWSE. In particular, as Budish et al. [12] point out that different mechanisms a periodical auction market and a continuous market have, stocks are auctioned in 5-second batch, and warrants are continuously traded on the TWSE during our sample period. Thus, such difference in trading mechanism between spot and warrant markets and a composition of investors on the warrant markets in Taiwan offers us an appropriate opportunity to investigate the behaviors of individual investors, who are likely to be speculators, as well as dealers, who are likely to be hedgers.

In this study, the studying period covers the whole year of 2014, which has a total of 245 trading days. We first obtain the characteristics of warrants, which include code of warrant, firm size of the underlying stock of warrant, effective leverage of warrant, time value of warrant, and implied volatility of warrant, from the Taiwan Economic Journal (TEJ) database. In addition, we use the dataset of warrants from the TWSE, which allows us to identify the investor type of each transaction to calculate the cross-sectional measures of disposition and confidence of individual investors and dealers in the year 2014, and further examine the PL of individual investors and dealers, respectively.

4. Methodology and Empirical Analysis

To begin with, we discuss coefficients of disposition as well as coefficients of confidence of individual investors and dealers, respectively. As Section 3 indicates, we separately use two different kinds of measurement, i.e., trading volume and number of transactions to calculate coefficients of disposition and coefficients of confidence because individual investors and dealers may have distinct trading behaviors (e.g., orders split, see *inter alia* Chakravarty [14] and Garvey et al. [26]), and trading volume and number of transactions may be disproportional for individual investors and dealers.

4.1. Coefficient of disposition

Consistent with Chou and Wang [16], who examine the disposition hypothesis, i.e., traders are more prone to liquidate their profitable long (short) positions bought (sold) on the previous trading day aggressively than to liquidate their losing long (short) positions, we follow the similar approach of Weber and Camerer [45] to define to individuals' coefficient of disposition in volume for each *call* warrant i as:

$$\mathrm{DP}_{v,i}^{\mathrm{ind}} = (S_{+}^{\mathrm{ind}} - S_{-}^{\mathrm{ind}})/(S_{+}^{\mathrm{ind}} + S_{-}^{\mathrm{ind}}) \tag{1}$$

where $\mathrm{DP}_{v,i}^{\mathrm{ind}}$ is the coefficient of disposition in volume of individual investors on warrant i; S_{+}^{ind} (S_{-}^{ind}) is the sum of individual investors' sell volume given that return of the underlying stock is positive (negative) on the previous trading day during the studying period. In contrast, for each *put* warrant, S_{+}^{ind} (S_{-}^{ind}) is the sum of individual investors' sell volume whose return of the underlying stock is negative (positive) on the previous trading day during the studying period. In addition, $\mathrm{DP}_{v,i}^{\mathrm{del}}$ is alternatively defined for dealers. Moreover, $\mathrm{DP}_{n,i}^{\mathrm{ind}}$ and $\mathrm{DP}_{n,i}^{\mathrm{del}}$, which are the coefficients of disposition in number of transactions, are calculated for individual investors and dealers, respectively. Coefficients of disposition here attempt to measure the difference in selling winners and losers normalized by the sum of selling for each warrant. In particular, Weber and Camerer [45] document that that investors incline to sell more when the price increases than they do when the price decreases if coefficient of disposition is positive, suggesting the exhibition of disposition effects. On the contrary, there is no disposition effect if coefficient of disposition is non-positive. In addition, the closer coefficient of disposition is to 1, the more is the intense propensity of disposition effects.

4.2. Coefficient of Confidence

Chou and Wang [16] examine the overconfidence hypothesis, i.e., traders are more prone to overweight their profitable long (short) positions bought (sold) on the previous trading day aggressively than to overweight their losing long (short) positions. Accordingly, we define to individual investors' coefficient of confidence in volume for each *call* warrant as:

$$\mathrm{CF}_{v,i}^{\mathrm{ind}} = (\mathrm{B}_{+}^{\mathrm{ind}} - \mathrm{B}_{-}^{\mathrm{ind}})/(\mathrm{B}_{+}^{\mathrm{ind}} + \mathrm{B}_{-}^{\mathrm{ind}}), \tag{2}$$

where $\mathrm{CF}_{v,i}^{\mathrm{ind}}$ is the coefficient of confidence in volume of individual investors on warrant i; $\mathrm{B}_{+}^{\mathrm{ind}}$ ($\mathrm{B}_{-}^{\mathrm{ind}}$) is the sum of individual investors' buy volume whose return of the underlying asset is positive (negative) on the previous trading day during the studying period. In contrast, for each *put* warrant, $\mathrm{B}_{+}^{\mathrm{ind}}$ ($\mathrm{B}_{-}^{\mathrm{ind}}$) is the sum of individual investors' buy volume whose return of the underlying stock is negative (positive) on the previous trading day during the studying period. In addition, $\mathrm{CF}_{v,i}^{\mathrm{del}}$ is alternatively defined for dealers. Moreover, $\mathrm{CF}_{n,i}^{\mathrm{ind}}$ and $\mathrm{CF}_{n,i}^{\mathrm{del}}$, which are the coefficients of confidence in number of transactions, are calculated for individual investors and dealers, respectively. Daniel et al. [18] argue that investors' overconfidence and self-attribution biases would lead to short-term momentum effects on stock prices. In addition, Daniel et al. [19] point out that overconfidence might cause over-reaction on stock prices. Thus, coefficients of confidence here aim to measure the difference between buying winners and losers. Investors incline to buy more when the price increases than they do when the price decreases if coefficient of confidence is positive, suggesting that the exhibition of overconfidence. On the contrary, there is no phenomenon of overconfidence if coefficient of confidence is non-positive. In addition, the closer coefficient of confidence to 1, the more intense propensity of overconfidence.

4.3. Analysis of coefficients of disposition and coefficients of confidence

Panels A and B of Table 1 report the means of coefficients of disposition and coefficients of confidence of individual investors and dealers, respectively. Interestingly, we find that individual investors seem to incline towards realizing their profits than dealers, because the mean of $\mathrm{DP}_{v,i}^{\mathrm{ind}}$ ($\mathrm{DP}_{n,i}^{\mathrm{ind}}$) is about 3.70 (4.20) times that of $\mathrm{DP}_{v,i}^{\mathrm{del}}$ ($\mathrm{DP}_{n,i}^{\mathrm{del}}$). On the other hand, dealers are more confident than individual investors, as the mean of $\mathrm{CF}_{v,i}^{\mathrm{del}}$ ($\mathrm{CF}_{n,i}^{\mathrm{del}}$) is about 7.52 (4.23) times that of $\mathrm{CF}_{v,i}^{\mathrm{ind}}$ ($\mathrm{CF}_{n,i}^{\mathrm{ind}}$).

Table 1: Summary Statistics.

Note: Panel A and Panel B of Table 1 report the summary statistics of coefficients of disposition and coefficients of confidence of individual investors and dealers, respectively.

In addition, Panel C and Panel D reveal the summary statistics of coefficient of disposition and coefficient of confidence on underlying stocks of individual investors and dealers, which are calculated by the same methodology with warrants, respectively. The statistics in trading volume are presented, and those in number of transactions are in parentheses.

Moreover, Panel E presents the summary statistics of warrants' characteristics, which include size of underlying stocks (Size), leverage (Lev), time value (TV), and implied volatility (IV). Size is revealed in thousand New Taiwan Dollar (TWD).

Panel A. Coefficient of Disposition on Warrants

$N = 7,878$	Coefficient of Disposition (DP)						
	Mean	Median	Standard Deviation	Max	Min	skewness	kurtosis
Individual Investors	0.216 (0.196)	0.226 (0.200)	0.304 (0.263)	1.000 (1.000)	-1.000 (-1.000)	-0.376 (-0.410)	0.670 (1.081)
Dealers	0.051 (0.053)	0.053 (0.060)	0.287 (0.249)	1.000 (1.000)	-1.000 (-1.000)	-0.120 (-0.224)	0.611 (0.745)

Panel B. Coefficient of Confidence on Warrants

$N = 7,878$	Coefficient of Confidence (CF)						
	Mean	Median	Standard Deviation	Max	Min	skewness	kurtosis
Individual Investors	0.027 (0.044)	0.023 (0.047)	0.298 (0.253)	1.000 (1.000)	-1.000 (-1.000)	-0.014 (-0.144)	0.541 (0.730)
Dealers	0.203 (0.186)	0.212 (0.195)	0.288 (0.252)	1.000 (1.000)	-1.000 (-1.000)	-0.381 (-0.429)	0.817 (1.228)

Panel C. Coefficient of Disposition on Underlying Stocks

$N = 7,878$	Coefficient of Disposition (DP)						
	Mean	Median	Standard Deviation	Max	Min	skewness	kurtosis
Individual Investors	0.107 (0.090)	0.115 (0.093)	0.089 (0.081)	0.404 (0.360)	-0.306 (-0.296)	-0.190 (-0.229)	0.348 (0.220)
Dealers	0.035 (0.016)	0.036 (0.025)	0.132 (0.125)	0.606 (0.493)	-0.568 (-0.552)	-0.184 (-0.275)	1.546 (1.146)

Panel D. Coefficient of Confidence on Underlying Stocks

$N = 7,878$	Coefficient of Confidence (CF)						
	Mean	Median	Standard Deviation	Max	Min	skewness	kurtosis
Individual Investors	0.031 (0.020)	0.021 (0.015)	0.103 (0.092)	0.316 (0.283)	-0.352 (-0.342)	-0.111 (-0.127)	-0.020 (0.124)
Dealers	0.077 (0.072)	0.075 (0.075)	0.117 (0.104)	0.658 (0.368)	-0.590 (-0.180)	-0.025 (-0.019)	1.356 (-0.515)

Panel E. Warrant Characteristics

$N = 7,878$	Mean	Median	Standard Deviation	Max	Min
Size	26,402,115	7,029,643	49,914,186	259,296,624	474,076
Lev	1.426	0.743	1.874	17.907	0.000
TV	0.431	0.358	0.379	7.219	0.000
IV	0.541	0.527	0.142	3.117	0.128

In addition, we obtain the dataset of warrant characteristics, i.e., size of underlying stocks (Size), leverage (Lev), time value (TV), and implied volatility (IV), from the Taiwan Economic Journal (TEJ). In particular, the leverage (Lev) of a warrant is defined as:

$$\text{Lev} = S \cdot \lambda / P \cdot \Delta, \tag{3}$$

where S is the price of the underlying stock, λ is the execution ratio, P is the price of the warrant, and Δ is the delta value of the warrant.

Note that TEJ applies the methodology of Black and Scholes [11] to calculate Δ, TV, and IV. Accordingly, Panel E of Table 1 presents the summary statistics of warrants' characteristics. It is worth noting that the average size of the underlying stocks is 26,402,115 thousand New Taiwan Dollar (TWD), which is 3.23 times of the average size of the whole stocks listed on the TWSE, indicating that the TWSE encourages dealers to issue warrants on large stocks.

In order to investigate the effects of warrants' characteristics on coefficients of disposition and coefficients of confidence, we conduct regression equations (4) and (5), i.e.,

$$\mathrm{DP}_{v,i}^{\mathrm{ind}} = \beta_0^{\mathrm{ind}} + \beta_1^{\mathrm{ind}}\mathrm{Call}_i + \beta_2^{\mathrm{ind}}\mathrm{Size}_i + \beta_3^{\mathrm{ind}}\mathrm{Lev}_i + \beta_4^{\mathrm{ind}}\mathrm{TV}_i + \beta_5^{\mathrm{ind}}\mathrm{IV}_i + \beta_6^{\mathrm{ind}}\mathrm{UDP}_{v,i}^{\mathrm{ind}} + \varepsilon_i^{\mathrm{ind}}, \quad (4)$$

$$\mathrm{DP}_{v,i}^{\mathrm{del}} = \beta_0^{\mathrm{del}} + \beta_1^{\mathrm{del}}\mathrm{Call}_i + \beta_2^{\mathrm{del}}\mathrm{Size}_i + \beta_3^{\mathrm{del}}\mathrm{Lev}_i + \beta_4^{\mathrm{del}}\mathrm{TV}_i + \beta_5^{\mathrm{del}}\mathrm{IV}_i + \beta_6^{\mathrm{del}}\mathrm{UDP}_{v,i}^{\mathrm{del}} + \varepsilon_i^{\mathrm{del}}, \quad (5)$$

where $\mathrm{DP}_{v,i}^{\mathrm{ind}}$ is the coefficient of disposition in volume of individual investors on warrant i; $\mathrm{DP}_{v,i}^{\mathrm{del}}$ is the coefficient of disposition in volume of dealers on warrant i; Call_i is a dummy variable, i.e., $\mathrm{Call}_i = 1$ if warrant i is a call warrant, and $\mathrm{Call}_i = 0$ otherwise; Size_i is the logarithm of the company size of the underlying stock of warrant i; Lev_i is the effective leverage of warrant i; TV_i is the time value of warrant i; IV_i is the implied volatility of warrant i; $\mathrm{UDP}_{v,i}^{\mathrm{ind}}$, and $\mathrm{UDP}_{v,i}^{\mathrm{del}}$ are individual investors' coefficient of disposition in volume on warrant i's underlying stock, and dealers' coefficient of disposition in volume on warrant i's underlying stock, respectively.

In addition, we apply the above methodology to explore the relations between coefficients of confidence and warrants' characteristics for individual investors and dealers, respectively, and we have:

$$\mathrm{CF}_{v,i}^{\mathrm{ind}} = \beta_0^{\mathrm{ind}} + \beta_1^{\mathrm{ind}}\mathrm{Call}_i + \beta_2^{\mathrm{ind}}\mathrm{Size}_i + \beta_3^{\mathrm{ind}}\mathrm{Lev}_i + \beta_4^{\mathrm{ind}}\mathrm{TV}_i + \beta_5^{\mathrm{ind}}\mathrm{IV}_i + \beta_6^{\mathrm{ind}}\mathrm{UCF}_{v,i}^{\mathrm{ind}} + \varepsilon_i^{\mathrm{ind}}, \quad (6)$$

$$\mathrm{CF}_{v,i}^{\mathrm{del}} = \beta_0^{\mathrm{del}} + \beta_1^{\mathrm{del}}\mathrm{Call}_i + \beta_2^{\mathrm{del}}\mathrm{Size}_i + \beta_3^{\mathrm{del}}\mathrm{Lev}_i + \beta_4^{\mathrm{del}}\mathrm{TV}_i + \beta_5^{\mathrm{del}}\mathrm{IV}_i + \beta_6^{\mathrm{del}}\mathrm{UCF}_{v,i}^{\mathrm{del}} + \varepsilon_i^{\mathrm{del}}, \quad (7)$$

where $\mathrm{CF}_{v,i}^{\mathrm{ind}}$ is the coefficient of confidence in volume of individual investors on warrant i; $\mathrm{CF}_{v,i}^{\mathrm{del}}$ is the coefficient of confidence in volume of dealers on warrant i; $\mathrm{UCF}_{v,i}^{\mathrm{ind}}$, and $\mathrm{UCF}_{v,i}^{\mathrm{del}}$ are individual investors' coefficient of confidence in volume on warrant i's underlying stock, dealers' coefficient of confidence in volume on warrant i's underlying stock, respectively.

Moreover, we conduct equations (4*), (5*), (6*), and (7*), in which coefficients of confidence and coefficients of disposition are measured in number of transactions, i.e.,

$$\mathrm{DP}_{n,i}^{\mathrm{ind}} = \beta_0^{\mathrm{ind}} + \beta_1^{\mathrm{ind}}\mathrm{Call}_i + \beta_2^{\mathrm{ind}}\mathrm{Size}_i + \beta_3^{\mathrm{ind}}\mathrm{Lev}_i + \beta_4^{\mathrm{ind}}\mathrm{TV}_i + \beta_5^{\mathrm{ind}}\mathrm{IV}_i + \beta_6^{\mathrm{ind}}\mathrm{UDP}_{vn,i}^{\mathrm{ind}} + \varepsilon_i^{\mathrm{ind}}, \quad (4^*)$$

$$\mathrm{DP}_{n,i}^{\mathrm{del}} = \beta_0^{\mathrm{del}} + \beta_1^{\mathrm{del}}\mathrm{Call}_i + \beta_2^{\mathrm{del}}\mathrm{Size}_i + \beta_3^{\mathrm{del}}\mathrm{Lev}_i + \beta_4^{\mathrm{del}}\mathrm{TV}_i + \beta_5^{\mathrm{del}}\mathrm{IV}_i + \beta_6^{\mathrm{del}}\mathrm{UDP}_{n,i}^{\mathrm{del}} + \varepsilon_i^{\mathrm{del}}, \quad (5^*)$$

$$\mathrm{CF}_{n,i}^{\mathrm{ind}} = \beta_0^{\mathrm{ind}} + \beta_1^{\mathrm{ind}}\mathrm{Call}_i + \beta_2^{\mathrm{ind}}\mathrm{Size}_i + \beta_3^{\mathrm{ind}}\mathrm{Lev}_i + \beta_4^{\mathrm{ind}}\mathrm{TV}_i + \beta_5^{\mathrm{ind}}\mathrm{IV}_i + \beta_6^{\mathrm{ind}}\mathrm{UCF}_{n,i}^{\mathrm{ind}} + \varepsilon_i^{\mathrm{ind}}, \quad (6^*)$$

$$\mathrm{CF}_{n,i}^{\mathrm{del}} = \beta_0^{\mathrm{del}} + \beta_1^{\mathrm{del}}\mathrm{Call}_i + \beta_2^{\mathrm{del}}\mathrm{Size}_i + \beta_3^{\mathrm{del}}\mathrm{Lev}_i + \beta_4^{\mathrm{del}}\mathrm{TV}_i + \beta_5^{\mathrm{del}}\mathrm{IV}_i + \beta_6^{\mathrm{del}}\mathrm{UCF}_{n,i}^{\mathrm{del}} + \varepsilon_i^{\mathrm{del}}, \quad (7^*)$$

where $\mathrm{DP}_{n,i}^{\mathrm{ind}}$ is the coefficient of disposition in number of transactions of individual investors on warrant i; $\mathrm{DP}_{n,i}^{\mathrm{del}}$ is the coefficient of disposition in number of transactions of dealers on warrant i; $\mathrm{CF}_{n,i}^{\mathrm{ind}}$ is the coefficient of confidence in number of transactions

Table 2: Analysis of Coefficients of Disposition and Characteristics of Warrants.

Note: In Table 2, models (4) and (5) present the relations between coefficients of disposition, which are measured in trading volume and warrant characteristics on individual investors and dealers, respectively. We conduct regression equations (4) and (5) to examine the impacts of warrants' characteristics on coefficients of disposition, i.e.,

$$\mathrm{DP}_{v,i}^{\mathrm{ind}} = \beta_0^{\mathrm{ind}} + \beta_1^{\mathrm{ind}}\mathrm{Call}_i + \beta_2^{\mathrm{ind}}\mathrm{Size}_i + \beta_3^{\mathrm{ind}}\mathrm{Lev}_i + \beta_4^{\mathrm{ind}}\mathrm{TV}_i + \beta_5^{\mathrm{ind}}\mathrm{IV}_i + \beta_6^{\mathrm{ind}}\mathrm{UDP}_{v,i}^{\mathrm{ind}} + \varepsilon_i^{\mathrm{ind}}, \quad (4)$$

$$\mathrm{DP}_{v,i}^{\mathrm{del}} = \beta_0^{\mathrm{del}} + \beta_1^{\mathrm{del}}\mathrm{Call}_i + \beta_2^{\mathrm{del}}\mathrm{Size}_i + \beta_3^{\mathrm{del}}\mathrm{Lev}_i + \beta_4^{\mathrm{del}}\mathrm{TV}_i + \beta_5^{\mathrm{del}}\mathrm{IV}_i + \beta_6^{\mathrm{del}}\mathrm{UDP}_{v,i}^{\mathrm{del}} + \varepsilon_i^{\mathrm{del}}. \quad (5)$$

Correspondingly, models (4*) and (5*) present presents he relations between coefficients of disposition, which are measured in number of transactions and warrant characteristics on individual investors and dealers, respectively. Thus, we have equations (4*) and (5*), in which disposition effects are measured in number of transactions, i.e.,

$$\mathrm{DP}_{n,i}^{\mathrm{ind}} = \beta_0^{\mathrm{ind}} + \beta_1^{\mathrm{ind}}\mathrm{Call}_i + \beta_2^{\mathrm{ind}}\mathrm{Size}_i + \beta_3^{\mathrm{ind}}\mathrm{Lev}_i + \beta_4^{\mathrm{ind}}\mathrm{TV}_i + \beta_5^{\mathrm{ind}}\mathrm{IV}_i + \beta_6^{\mathrm{ind}}\mathrm{UDP}_{vn,i}^{\mathrm{ind}} + \varepsilon_i^{\mathrm{ind}}, \quad (4^*)$$

$$\mathrm{DP}_{n,i}^{\mathrm{del}} = \beta_0^{\mathrm{del}} + \beta_1^{\mathrm{del}}\mathrm{Call}_i + \beta_2^{\mathrm{del}}\mathrm{Size}_i + \beta_3^{\mathrm{del}}\mathrm{Lev}_i + \beta_4^{\mathrm{del}}\mathrm{TV}_i + \beta_5^{\mathrm{del}}\mathrm{IV}_i + \beta_6^{\mathrm{del}}\mathrm{UDP}_{n,i}^{\mathrm{del}} + \varepsilon_i^{\mathrm{del}}. \quad (5^*)$$

We present parameter estimates and the corresponding t values in parentheses by fitting the data with GMM, and the symbols $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% level, respectively.

Individual Investors			Dealers		
	Model (4)	Model (4*)		Model (5)	Model (5*)
$\hat{\beta}_0^{\mathrm{ind}}$	0.293***	0.414***	$\hat{\beta}_0^{\mathrm{del}}$	0.361***	0.483***
	(4.169)	(6.532)		(4.776)	(7.775)
$\hat{\beta}_1^{\mathrm{ind}}$	0.132***	0.078***	$\hat{\beta}_1^{\mathrm{del}}$	0.055***	0.036***
	(13.376)	(9.095)		(5.903)	(4.228)
$\hat{\beta}_2^{\mathrm{ind}}$	-0.023***	-0.027***	$\hat{\beta}_2^{\mathrm{del}}$	-0.021***	-0.028***
	(-5.996)	(-8.138)		(-5.483)	(-8.476)
$\hat{\beta}_3^{\mathrm{ind}}$	0.033***	0.030***	$\hat{\beta}_3^{\mathrm{del}}$	0.024***	0.029***
	(12.814)	(14.175)		(9.435)	(12.799)
$\hat{\beta}_4^{\mathrm{ind}}$	0.020**	0.012	$\hat{\beta}_4^{\mathrm{del}}$	0.019**	0.005
	(2.330)	(1.635)		(2.321)	(0.699)
$\hat{\beta}_5^{\mathrm{ind}}$	0.138***	0.095***	$\hat{\beta}_5^{\mathrm{del}}$	-0.121***	-0.122***
	(4.228)	(2.958)		(-2.936)	(-3.746)
$\hat{\beta}_6^{\mathrm{ind}}$	0.472***	0.542***	$\hat{\beta}_6^{\mathrm{del}}$	0.196***	0.224***
	(11.465)	(14.040)		(6.699)	(8.684)
Adjusted R-squared	7.996%	7.066%	Adjusted R-squared	3.714%	4.753%

of individual investors on warrant i; $\mathrm{CF}_{n,i}^{\mathrm{del}}$ is the coefficient of confidence in number of transactions of dealers on warrant i.

Accordingly, Table 2 reports the empirical results of equations (4) and (5), in which coefficients of disposition are calculated in trading volume, and the empirical results of equations (4^*) and (5^*), in which coefficients of disposition are calculated in number of transactions. In general, the empirical results demonstrate that warrants' characteristics have similar influence upon coefficients of disposition of individual investors and dealers. First, the relation between size of underlying stock and coefficient of disposition is negative for both individual investors and dealers as evidenced by $\hat{\beta}_2^{\mathrm{ind}}$ and $\hat{\beta}_2^{\mathrm{del}}$ being negative at the 1% significance level respectively in equations (4), (4^*), (5), and (5^*), suggesting that both individual investors and dealers tend to realize their profits on the warrants whose underlying stocks in smaller scale, which are likely to be less transparent than larger stocks. Second, the positive relation between coefficient of disposition and effective leverage for both individual investors and dealer, as evidenced by $\hat{\beta}_3^{\mathrm{ind}}$ and $\hat{\beta}_3^{\mathrm{del}}$ being positive at the 1% significance level respectively in equations (4), (4^*), (5), and (5^*), indicating that the higher effective leverage of warrants, the more eager both types of investors to realize their profits. These two phenomena suggest that both individual investors and dealers are likely to play the role as speculators in Taiwan's warrant markets. Third, the relation between coefficient of disposition and time value of warrants is slightly positive, and only $\hat{\beta}_4^{\mathrm{ind}}$ and $\hat{\beta}_4^{\mathrm{del}}$ positive at the 5% significance level in equations (4) and (5), respectively. Interestingly, we find that the relation between warrants' coefficients of disposition and their corresponding underlying stocks' coefficients of disposition is significantly positive for both individual investors and dealers, and the relation is particularly strong for individual investors. Such empirical results indicate that there are positive linkages with cross-market spillover effects on coefficients of disposition between spot markets and the corresponding warrant markets, which are similar with the spillover effects of volatility (see e.g., Baele [3]; Kanas [31]; Baba [2]) and news (see e.g., Gande and Parsley [25]; Kim [32]; Ferreira and Gama [23]) in many financial markets.

On the other hand, as equations (4), (4^*), (5), and (5^*) reveal, the coefficients of disposition on call warrants are much stronger than on put warrants as evidenced by $\hat{\beta}_0^{\mathrm{ind}}$ being positive at the 1% significance level, suggesting that there are more unsophisticated individual investors that prefer to realize profits on call warrants than put warrants, consistent with Doran et al. [22], who point out that naive individual investors tend to trade calls than puts. On the contrary, we find that the differences between call warrants and put warrants on dealers are relatively slight, with comparison of estimates of $\hat{\beta}_1^{\mathrm{ind}}$ and $\hat{\beta}_1^{\mathrm{del}}$ in equations (4) and (5) as well as (4^*) and (5^*).

On the other hand, the results in Table 2 demonstrate that the coefficients of disposition of individual investors and dealers are opposite towards implied volatility, as evidenced by $\hat{\beta}_5^{\mathrm{ind}}$ being positive at the 1% significance level in equations (4) and (4^*), while $\hat{\beta}_5^{\mathrm{del}}$ being negative at the 1% significance level in equations (5) and (5^*). Such results are consistent with Chang et al. [13], who conclude that individual investors are more eager to transact during periods of higher uncertAindy than institutional investors.

Similar with Table 2, Table 3 presents the empirical results of the relations between coefficients of confidence, which are measured in trading volume and in number of transactions, and characteristics of warrants for individual investors and dealers, respectively. Surprisingly, there are a lot of similarities between the results in Table 2 and Table 3. The relation between size of underlying stock and coefficient of confidence is also negative

Table 3: Analysis of Coefficients of Confidence and Characteristics of Warrants.

Note: In Table 3, models (6) and (7) present the relations between coefficients of confidence, which are measured in trading volume and warrant characteristics on individual investors and dealers, respectively. We conduct regression equations (6) and (7) to examine the impacts of warrants' characteristics on coefficients of confidence, i.e.,

$$\mathrm{CF}^{\mathrm{ind}}_{v,i} = \beta^{\mathrm{ind}}_0 + \beta^{\mathrm{ind}}_1 \mathrm{Call}_i + \beta^{\mathrm{ind}}_2 \mathrm{Size}_i + \beta^{\mathrm{ind}}_3 \mathrm{Lev}_i + \beta^{\mathrm{ind}}_4 \mathrm{TV}_i + \beta^{\mathrm{ind}}_5 \mathrm{IV}_i + \beta^{\mathrm{ind}}_6 \mathrm{UCF}^{\mathrm{ind}}_{v,i} + \varepsilon^{\mathrm{ind}}_i, \quad (6)$$
$$\mathrm{CF}^{\mathrm{del}}_{v,i} = \beta^{\mathrm{del}}_0 + \beta^{\mathrm{del}}_1 \mathrm{Call}_i + \beta^{\mathrm{del}}_2 \mathrm{Size}_i + \beta^{\mathrm{del}}_3 \mathrm{Lev}_i + \beta^{\mathrm{del}}_4 \mathrm{TV}_i + \beta^{\mathrm{del}}_5 \mathrm{IV}_i + \beta^{\mathrm{del}}_6 \mathrm{UCF}^{\mathrm{del}}_{v,i} + \varepsilon^{\mathrm{del}}_i. \quad (7)$$

Correspondingly, models (6*) and (7*) present presents he relations between coefficients of confidence, which are measured in number of transactions and warrant characteristics on individual investors and dealers, respectively. Thus, we have equations (6*) and (7*), in which confidence effects are measured in number of transactions, i.e.,

$$\mathrm{CF}^{\mathrm{ind}}_{n,i} = \beta^{\mathrm{ind}}_0 + \beta^{\mathrm{ind}}_1 \mathrm{Call}_i + \beta^{\mathrm{ind}}_2 \mathrm{Size}_i + \beta^{\mathrm{ind}}_3 \mathrm{Lev}_i + \beta^{\mathrm{ind}}_4 \mathrm{TV}_i + \beta^{\mathrm{ind}}_5 \mathrm{IV}_i + \beta^{\mathrm{ind}}_6 \mathrm{UCF}^{\mathrm{ind}}_{n,i} + \varepsilon^{\mathrm{ind}}_i, \quad (6^*)$$
$$\mathrm{CF}^{\mathrm{del}}_{n,i} = \beta^{\mathrm{del}}_0 + \beta^{\mathrm{del}}_1 \mathrm{Call}_i + \beta^{\mathrm{del}}_2 \mathrm{Size}_i + \beta^{\mathrm{del}}_3 \mathrm{Lev}_i + \beta^{\mathrm{del}}_4 \mathrm{TV}_i + \beta^{\mathrm{del}}_5 \mathrm{IV}_i + \beta^{\mathrm{del}}_6 \mathrm{UCF}^{\mathrm{del}}_{n,i} + \varepsilon^{\mathrm{del}}_i. \quad (7^*)$$

We present parameter estimates and the corresponding t values by fitting the data with GMM, and the symbols $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% level, respectively.

Individual Investors			Dealers		
	Model (6)	Model (6*)		Model (7)	Model (7*)
$\hat{\beta}^{\mathrm{ind}}_0$	0.206***	0.333***	$\hat{\beta}^{\mathrm{del}}_0$	0.243***	0.375***
	(2.674)	(5.458)		(3.603)	(6.223)
$\hat{\beta}^{\mathrm{ind}}_1$	0.023**	0.010	$\hat{\beta}^{\mathrm{del}}_1$	0.131***	0.082***
	(2.403)	(1.232)		(13.539)	(9.716)
$\hat{\beta}^{\mathrm{ind}}_2$	-0.010**	-0.017***	$\hat{\beta}^{\mathrm{del}}_2$	-0.018***	-0.022***
	(-2.493)	(-5.057)		(-4.904)	(-6.975)
$\hat{\beta}^{\mathrm{ind}}_3$	0.018***	0.023***	$\hat{\beta}^{\mathrm{del}}_3$	0.027***	0.024***
	(6.809)	(9.956)		(10.965)	(11.427)
$\hat{\beta}^{\mathrm{ind}}_4$	0.012	0.009	$\hat{\beta}^{\mathrm{del}}_4$	0.020**	0.02***
	(1.560)	(1.386)		(2.494)	(2.780)
$\hat{\beta}^{\mathrm{ind}}_5$	-0.152***	-0.137***	$\hat{\beta}^{\mathrm{del}}_5$	0.122***	0.057*
	(-3.686)	(-4.672)		(3.862)	(1.942)
$\hat{\beta}^{\mathrm{ind}}_6$	0.442***	0.505***	$\hat{\beta}^{\mathrm{del}}_6$	0.311***	0.337***
	(11.880)	(14.849)		(10.655)	(11.965)
Adjusted R-squared	4.297%	6.181%	Adjusted R-squared	8.185%	6.667%

for both individual investors and dealers, implying that behavioral biases are less severe in trading larger stocks, which are more transparent with less information asymmetry (see e.g., Diamond and Verrecchia [20]; Kot [33]; LaFond and Watts [36]). In addition, the relation between coefficient of confidence and effective leverage for both individual investors and dealers is also positive, revealing the other side of warrants trading, i.e., lottery-like securities, because leverage functions as one of the most significant features of gambling (Kumar [34]). In particular, most gamblers are confident and eager to realize their profits (Abreu [1]), since our empirical results also demonstrate that the relations between coefficients of disposition and effective leverage are also positive. In addition, the relation between coefficient of confidence and time value of warrants is also slightly positive, and only is positive at the 1% significance level in equation (7*). Moreover, our empirical results also indicate positive relations on coefficients of confidence between spot markets and the corresponding warrant markets both for individual investors and dealers, as evidenced by $\hat{\beta}_0^{\text{del}}$ being significantly positive at the 1% level in equations (6), (6*), (7), and (7*).

On the contrary, our empirical results also indicate that dealers are more confident on call warrants than put warrants, as evidenced by $\hat{\beta}_1^{\text{del}}$ being positive at the 1% significance level in equations (7) and (7*). Such differences between call warrants and put warrants on individual investors are relatively slight, as is not significantly positive at the 5% level in equations (6) and (6*).

On the other hand, the results in Table 3 indicate that the relations between coefficients of confidence and implied volatility demonstrate quite different patterns for individual investors and dealers, i.e., $\hat{\beta}_1^{\text{ind}}$ is significantly negative at the 1% significance level in equations (6) and (6*), and $\hat{\beta}_5^{\text{del}}$ is significantly positive at the 1% level in equation (7), suggesting that individual investors become less confident, while dealers become more confident on more volatile warrants. Same with coefficients of disposition, the empirical results indicate that the relation between warrants' coefficients of confidence and their corresponding underlying stocks' coefficients of confidence is significantly positive for both individual investors and dealers, suggesting positive linkages with cross-market spillover effects again.

4.4. Profits and losses, coefficients of disposition, and coefficients of confidence

After exploring the warrant characteristics that are likely to influence coefficients of disposition and coefficients of confidence on individual investors and dealers, we further analyze the profits and losses (PL) of individual investors and dealers during each warrant's maturity. Thus, for each warrant, the PL of individual investors and dealers are respectively calculated based on their trading price multiplied by the volume of each transaction during the whole studying period, i.e., we calculate the sum of the trading price multiplied by the volume of each selling transaction, and then minus the sum of the trading price multiplied by the volume of each buying transaction for individual investors and dealers, respectively. Finally, the PL of the open interest on the last trading day is added according to the rules of cash settlement.

Table 4 reveals the summary statistics of PL of individual investors and dealers on call and put warrants, respectively. Interestingly, we find that what dealers gain is almost what individual investors lose, consistent with the fact that few other types of investors trade warrants other than individual investors and dealers in Taiwan. Second, we find that individual investors lose more money on put warrants than call warrants on average. In contrast, dealers win more money on put warrants than call warrants on average.

Table 4: Profits and Losses of Individual Investors and Dealers.

Note: Table 4 presents the summary statistics on profits and losses (PL) of individual investors (PL^{ind}) and dealers (PL^{del}) of call and put warrant in thousand TWD, respectively. For each warrant, PLind and PLdel are respectively calculated based on their trading price multiplied by the volume of each transaction during the whole studying period, i.e., we calculate the sum of the trading price multiplied by the volume of each selling transaction, and then minus the sum of the trading price multiplied by the volume of each buying transaction for individual investors and dealers, respectively. Finally, the PL of the open interest on the last trading day are added according to the rules of cash settlement.

	Call Warrants ($N = 6,516$)		Put Warrants ($N = 1,326$)	
	PL^{ind}	PL^{del}	PL^{ind}	PL^{del}
Mean	-380	384	-434	439
Median	-137	138	-151	151
Standard Deviation	2,178	2,183	1,721	1,721
Max.	27,152	34,567	8,404	17,696
Min.	-34,571	-27,101	-17,694	-7,808
Skewness	-2.230	2.223	-3.963	4.005
Kurtosis	40.931	40.677	30.570	30.607

In section 4.1, we demonstrate that warrant characteristics have impacts upon coefficients of disposition as well as coefficients of confidence of both two types of investors, individual investors and dealers. This motivates us to further study whether the changes in coefficients of disposition as well as coefficients of confidence of the two types of investors could provide help in explaining PL, with exclusion of influences of characteristics of warrants.

To this end, we conduct the following two-stage approach to investigate the relations among PL, coefficients of disposition, and coefficients of confidence of individual investors and dealers, respectively, i.e.:

Stage 1

$$
\begin{aligned}
\text{DP}^{\text{ind}}_{v,i} &= \beta^{\text{ind}}_{\text{DP},0} + \beta^{\text{ind}}_{\text{DP},1}\text{Call}_i + \beta^{\text{ind}}_{\text{DP},2}\text{Size}_i + \beta^{\text{ind}}_{\text{DP},3}\text{Lev}_i + \beta^{\text{ind}}_{\text{DP},4}\text{TV}_i + \beta^{\text{ind}}_{\text{DP},5}\text{IV}_i + \varepsilon^{\text{ind}}_{\text{DP},i},\\
\text{CF}^{\text{ind}}_{v,i} &= \beta^{\text{ind}}_{\text{CF},0} + \beta^{\text{ind}}_{\text{CF},1}\text{Call}_i + \beta^{\text{ind}}_{\text{CF},2}\text{Size}_i + \beta^{\text{ind}}_{\text{CF},3}\text{Lev}_i + \beta^{\text{ind}}_{\text{CF},4}\text{TV}_i + \beta^{\text{ind}}_{\text{CF},5}\text{IV}_i + \varepsilon^{\text{ind}}_{\text{CF},i},\\
\text{DP}^{\text{del}}_{v,i} &= \beta^{\text{del}}_{\text{DP},0} + \beta^{\text{del}}_{\text{DP},1}\text{Call}_i + \beta^{\text{del}}_{\text{DP},2}\text{Size}_i + \beta^{\text{del}}_{\text{DP},3}\text{Lev}_i + \beta^{\text{del}}_{\text{DP},4}\text{TV}_i + \beta^{\text{del}}_{\text{DP},5}\text{IV}_i + \varepsilon^{\text{del}}_{\text{DP},i},\\
\text{CF}^{\text{del}}_{v,i} &= \beta^{\text{del}}_{\text{CF},0} + \beta^{\text{del}}_{\text{CF},1}\text{Call}_i + \beta^{\text{del}}_{\text{CF},2}\text{Size}_i + \beta^{\text{del}}_{\text{CF},3}\text{Lev}_i + \beta^{\text{del}}_{\text{CF},4}\text{TV}_i + \beta^{\text{del}}_{\text{CF},5}\text{IV}_i + \varepsilon^{\text{del}}_{\text{CF},i}.
\end{aligned}
\tag{8}
$$

Stage 2

$$
\text{PL}^{\text{ind}}_i = \alpha^{\text{ind}}_0 + \alpha^{\text{ind}}_1\hat{\varepsilon}^{\text{ind}}_{\text{DP},i} + \alpha^{\text{ind}}_2\hat{\varepsilon}^{\text{ind}}_{\text{CF},i} + \alpha^{\text{ind}}_3\hat{\varepsilon}^{\text{ind}}_{\text{DP},i} + \alpha^{\text{ind}}_4\hat{\varepsilon}^{\text{ind}}_{\text{CF},i} + \varepsilon^{\text{ind}}_{\text{PL},i},
$$

$$\mathrm{PL}_i^{\mathrm{del}} = \alpha_0^{\mathrm{ind}} + \alpha_1^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{del}} + \alpha_2^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{del}} + \alpha_3^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{del}} + \alpha_4^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{del}} + \varepsilon_{\mathrm{PL},i}^{\mathrm{del}},$$

where $\varepsilon_{\mathrm{DP},i}^{\mathrm{ind}}$, $\varepsilon_{\mathrm{CF},i}^{\mathrm{ind}}$, $\varepsilon_{\mathrm{DP},i}^{\mathrm{del}}$, $\varepsilon_{\mathrm{CF},i}^{\mathrm{del}}$ and are residuals obtained, respectively, by fitting the four regressions in Stage 1. Note that Stage 1 enables us to deduct the effects of warrant characteristics on coefficients of disposition as well as coefficients of confidence, while Stage 2 allows us to assess the contributions of coefficients of disposition as well as coefficients of confidence on PL, after removing the effects of warrant characteristics.

Correspondingly, we also conduct equations (8*) to analyze the relations with coefficients of disposition and coefficients of confidence in number of transactions, i.e.,

Stage 1

$$\begin{aligned}
\mathrm{DP}_{n,i}^{\mathrm{ind}} &= \beta_{\mathrm{DP},0}^{\mathrm{ind}} + \beta_{\mathrm{DP},1}^{\mathrm{ind}}\mathrm{Call}_i + \beta_{\mathrm{DP},2}^{\mathrm{ind}}\mathrm{Size}_i + \beta_{\mathrm{DP},3}^{\mathrm{ind}}\mathrm{Lev}_i + \beta_{\mathrm{DP},4}^{\mathrm{ind}}\mathrm{TV}_i + \beta_{\mathrm{DP},5}^{\mathrm{ind}}\mathrm{IV}_i + \varepsilon_{\mathrm{DP},i}^{\mathrm{ind}},\\
\mathrm{CF}_{n,i}^{\mathrm{ind}} &= \beta_{\mathrm{CF},0}^{\mathrm{ind}} + \beta_{\mathrm{CF},1}^{\mathrm{ind}}\mathrm{Call}_i + \beta_{\mathrm{CF},2}^{\mathrm{ind}}\mathrm{Size}_i + \beta_{\mathrm{CF},3}^{\mathrm{ind}}\mathrm{Lev}_i + \beta_{\mathrm{CF},4}^{\mathrm{ind}}\mathrm{TV}_i + \beta_{\mathrm{CF},5}^{\mathrm{ind}}\mathrm{IV}_i + \varepsilon_{\mathrm{CF},i}^{\mathrm{ind}},\\
\mathrm{DP}_{n,i}^{\mathrm{del}} &= \beta_{\mathrm{DP},0}^{\mathrm{del}} + \beta_{\mathrm{DP},1}^{\mathrm{del}}\mathrm{Call}_i + \beta_{\mathrm{DP},2}^{\mathrm{del}}\mathrm{Size}_i + \beta_{\mathrm{DP},3}^{\mathrm{del}}\mathrm{Lev}_i + \beta_{\mathrm{DP},4}^{\mathrm{del}}\mathrm{TV}_i + \beta_{\mathrm{DP},5}^{\mathrm{del}}\mathrm{IV}_i + \varepsilon_{\mathrm{DP},i}^{\mathrm{del}},\\
\mathrm{CF}_{n,i}^{\mathrm{del}} &= \beta_{\mathrm{CF},0}^{\mathrm{del}} + \beta_{\mathrm{CF},1}^{\mathrm{del}}\mathrm{Call}_i + \beta_{\mathrm{CF},2}^{\mathrm{del}}\mathrm{Size}_i + \beta_{\mathrm{CF},3}^{\mathrm{del}}\mathrm{Lev}_i + \beta_{\mathrm{CF},4}^{\mathrm{del}}\mathrm{TV}_i + \beta_{\mathrm{CF},5}^{\mathrm{del}}\mathrm{IV}_i + \varepsilon_{\mathrm{CF},i}^{\mathrm{del}}.
\end{aligned} \tag{8*}$$

Stage 2

$$\begin{aligned}
\mathrm{PL}_i^{\mathrm{ind}} &= \alpha_0^{\mathrm{ind}} + \alpha_1^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{ind}} + \alpha_2^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{ind}} + \alpha_3^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{ind}} + \alpha_4^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{ind}} + \varepsilon_{\mathrm{PL},i}^{\mathrm{ind}},\\
\mathrm{PL}_i^{\mathrm{del}} &= \alpha_0^{\mathrm{ind}} + \alpha_1^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{del}} + \alpha_2^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{del}} + \alpha_3^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{del}} + \alpha_4^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{del}} + \varepsilon_{\mathrm{PL},i}^{\mathrm{del}}.
\end{aligned}$$

For brevity, we only report the empirical results of Stage 2 since the relations among coefficients of disposition and coefficients of confidence and warrant characteristics have been presented in the previous sections. Accordingly, Table 5 reveals the impacts of coefficients of disposition and coefficients of confidence with exclusion of influences of warrant characteristics, on PL of individual investors and dealers, respectively. Interestingly, the empirical results indicate that PL of individual investors are positively related to their own coefficient of disposition as well as dealers' coefficient of disposition. Such results suggest that in general, individual investors' losses are less on their eager behaviors to realize their profits. In contrast, dealers' profits are significantly reduced when dealer are actively to realize their profits as evidenced by $\hat{\alpha}_3^{\mathrm{del}}$ being negative at the 1% significance level in equations (8) and (8*).

On the other hand, individual investors' PL are negatively related to their own coefficient of confidence in relatively slight scale as evidenced by $\hat{\alpha}_2^{\mathrm{ind}}$ being negative at the 5% significance level in equations (8*), consistent with Barber and Odean [6] and Barber and Odean [7], who point out that excess trading due to overconfidence hurts individual investors' wealth. On the contrary, we find that dealers are likely to be better informed because their trading performance are positively related to their coefficient of confidence as evidenced by $\hat{\alpha}_4^{\mathrm{ind}}$ being positive at the 1% significance level both in equations (8) and (8*). In sum, such results imply that individual investors are likely to be uninformed traders in warrant markets, who are likely to be hurt by overtrading due to overconfidence and had better realize their profits soon, while dealers are informed traders, who are likely to benefit from trading and gain more for a longer holding period in warrant markets.

Table 5: Profits & Losses, Coefficients of Disposition, and Coefficients of Confidence.

Note: Table 5 presents the relations among PL, coefficients of disposition, and coefficients of confidence. We conduct two-stage approach to investigate the relations among PL, coefficients of disposition, and coefficients of confidence of individual investors and dealers, respectively, i.e.,

Stage 1

$$\begin{aligned}
\mathrm{DP}^{\mathrm{ind}}_{n,i} &= \beta^{\mathrm{ind}}_{\mathrm{DP},0}+\beta^{\mathrm{ind}}_{\mathrm{DP},1}\mathrm{Call}_i+\beta^{\mathrm{ind}}_{\mathrm{DP},2}\mathrm{Size}_i+\beta^{\mathrm{ind}}_{\mathrm{DP},3}\mathrm{Lev}_i+\beta^{\mathrm{ind}}_{\mathrm{DP},4}\mathrm{TV}_i+\beta^{\mathrm{ind}}_{\mathrm{DP},5}\mathrm{IV}_i+\varepsilon^{\mathrm{ind}}_{\mathrm{DP},i},\\
\mathrm{CF}^{\mathrm{ind}}_{n,i} &= \beta^{\mathrm{ind}}_{\mathrm{CF},0}+\beta^{\mathrm{ind}}_{\mathrm{CF},1}\mathrm{Call}_i+\beta^{\mathrm{ind}}_{\mathrm{CF},2}\mathrm{Size}_i+\beta^{\mathrm{ind}}_{\mathrm{CF},3}\mathrm{Lev}_i+\beta^{\mathrm{ind}}_{\mathrm{CF},4}\mathrm{TV}_i+\beta^{\mathrm{ind}}_{\mathrm{CF},5}\mathrm{IV}_i+\varepsilon^{\mathrm{ind}}_{\mathrm{CF},i},\\
\mathrm{DP}^{\mathrm{del}}_{n,i} &= \beta^{\mathrm{del}}_{\mathrm{DP},0}+\beta^{\mathrm{del}}_{\mathrm{DP},1}\mathrm{Call}_i+\beta^{\mathrm{del}}_{\mathrm{DP},2}\mathrm{Size}_i+\beta^{\mathrm{del}}_{\mathrm{DP},3}\mathrm{Lev}_i+\beta^{\mathrm{del}}_{\mathrm{DP},4}\mathrm{TV}_i+\beta^{\mathrm{del}}_{\mathrm{DP},5}\mathrm{IV}_i+\varepsilon^{\mathrm{del}}_{\mathrm{DP},i},\\
\mathrm{CF}^{\mathrm{del}}_{n,i} &= \beta^{\mathrm{del}}_{\mathrm{CF},0}+\beta^{\mathrm{del}}_{\mathrm{CF},1}\mathrm{Call}_i+\beta^{\mathrm{del}}_{\mathrm{CF},2}\mathrm{Size}_i+\beta^{\mathrm{del}}_{\mathrm{CF},3}\mathrm{Lev}_i+\beta^{\mathrm{del}}_{\mathrm{CF},4}\mathrm{TV}_i+\beta^{\mathrm{del}}_{\mathrm{CF},5}\mathrm{IV}_i+\varepsilon^{\mathrm{del}}_{\mathrm{CF},i}.
\end{aligned} \tag{8}$$

Stage 2

$$\begin{aligned}
\mathrm{PL}^{\mathrm{ind}}_i &= \alpha^{\mathrm{ind}}_0+\alpha^{\mathrm{ind}}_1\hat{\varepsilon}^{\mathrm{ind}}_{\mathrm{DP},i}+\alpha^{\mathrm{ind}}_2\hat{\varepsilon}^{\mathrm{ind}}_{\mathrm{CF},i}+\alpha^{\mathrm{ind}}_3\hat{\varepsilon}^{\mathrm{ind}}_{\mathrm{DP},i}+\alpha^{\mathrm{ind}}_4\hat{\varepsilon}^{\mathrm{ind}}_{\mathrm{CF},i}+\varepsilon^{\mathrm{ind}}_{\mathrm{PL},i},\\
\mathrm{PL}^{\mathrm{del}}_i &= \alpha^{\mathrm{ind}}_0+\alpha^{\mathrm{del}}_1\hat{\varepsilon}^{\mathrm{del}}_{\mathrm{DP},i}+\alpha^{\mathrm{del}}_2\hat{\varepsilon}^{\mathrm{del}}_{\mathrm{CF},i}+\alpha^{\mathrm{del}}_3\hat{\varepsilon}^{\mathrm{del}}_{\mathrm{DP},i}+\alpha^{\mathrm{del}}_4\hat{\varepsilon}^{\mathrm{del}}_{\mathrm{CF},i}+\varepsilon^{\mathrm{del}}_{\mathrm{PL},i},
\end{aligned}$$

where $\varepsilon^{\mathrm{ind}}_{\mathrm{DP},i}$, $\varepsilon^{\mathrm{ind}}_{\mathrm{CF},i}$, $\varepsilon^{\mathrm{del}}_{\mathrm{DP},i}$, and $\varepsilon^{\mathrm{del}}_{\mathrm{CF},i}$ are residuals obtained, respectively, by fitting the four regressions in Stage 1. Correspondingly, Panel B of Table 5 presents the empirical results, which include coefficients of disposition and coefficients of confidence in number of transactions, i.e.,

Panel A. In Trading Volume (8)					
Individual Investors			Dealers		
	Estimate	t value		Estimate	t value
$\hat{\alpha}^{\mathrm{ind}}_0$	-389.19***	-16.372	$\hat{\alpha}^{\mathrm{del}}_0$	393.26***	16.519
$\hat{\alpha}^{\mathrm{ind}}_1$	1926.20***	10.501	$\hat{\alpha}^{\mathrm{del}}_1$	-1918.00***	-10.402
$\hat{\alpha}^{\mathrm{ind}}_2$	-78.62	-0.477	$\hat{\alpha}^{\mathrm{del}}_2$	78.52	0.476
$\hat{\alpha}^{\mathrm{ind}}_3$	718.22***	3.870	$\hat{\alpha}^{\mathrm{del}}_3$	-718.10***	-3.865
$\hat{\alpha}^{\mathrm{ind}}_4$	-609.90***	-3.178	$\hat{\alpha}^{\mathrm{del}}_4$	603.61***	3.129
Adjusted R-squared: 5.545%			Adjusted R-squared: 5.506%		
Panel B. In Number of Transaction (8*)					
Individual Investors			Dealers		
	Estimate	t value		Estimate	t value
$\hat{\alpha}^{\mathrm{ind}}_0$	-389.19***	-16.464	$\hat{\alpha}^{\mathrm{del}}_0$	393.26***	16.615
$\hat{\alpha}^{\mathrm{ind}}_1$	3186.40***	10.470	$\hat{\alpha}^{\mathrm{del}}_1$	-3186.80***	-10.397
$\hat{\alpha}^{\mathrm{ind}}_2$	-615.10**	-2.279	$\hat{\alpha}^{\mathrm{del}}_2$	610.01**	2.267
$\hat{\alpha}^{\mathrm{ind}}_3$	1557.40***	5.218	$\hat{\alpha}^{\mathrm{del}}_3$	-1552.20***	-5.216
$\hat{\alpha}^{\mathrm{ind}}_4$	-1922.50***	-6.095	$\hat{\alpha}^{\mathrm{del}}_4$	1926.30***	6.063
Adjusted R-squared: 6.148%			Adjusted R-squared: 6.110%		

Stage 1

$$\begin{aligned}
\mathrm{DP}_{n,i}^{\mathrm{ind}} &= \beta_{\mathrm{DP},0}^{\mathrm{ind}}+\beta_{\mathrm{DP},1}^{\mathrm{ind}}\mathrm{Call}_i+\beta_{\mathrm{DP},2}^{\mathrm{ind}}\mathrm{Size}_i+\beta_{\mathrm{DP},3}^{\mathrm{ind}}\mathrm{Lev}_i+\beta_{\mathrm{DP},4}^{\mathrm{ind}}\mathrm{TV}_i+\beta_{\mathrm{DP},5}^{\mathrm{ind}}\mathrm{IV}_i+\varepsilon_{\mathrm{DP},i}^{\mathrm{ind}},\\
\mathrm{CF}_{n,i}^{\mathrm{ind}} &= \beta_{\mathrm{CF},0}^{\mathrm{ind}}+\beta_{\mathrm{CF},1}^{\mathrm{ind}}\mathrm{Call}_i+\beta_{\mathrm{CF},2}^{\mathrm{ind}}\mathrm{Size}_i+\beta_{\mathrm{CF},3}^{\mathrm{ind}}\mathrm{Lev}_i+\beta_{\mathrm{CF},4}^{\mathrm{ind}}\mathrm{TV}_i+\beta_{\mathrm{CF},5}^{\mathrm{ind}}\mathrm{IV}_i+\varepsilon_{\mathrm{CF},i}^{\mathrm{ind}},\\
\mathrm{DP}_{n,i}^{\mathrm{del}} &= \beta_{\mathrm{DP},0}^{\mathrm{del}}+\beta_{\mathrm{DP},1}^{\mathrm{del}}\mathrm{Call}_i+\beta_{\mathrm{DP},2}^{\mathrm{del}}\mathrm{Size}_i+\beta_{\mathrm{DP},3}^{\mathrm{del}}\mathrm{Lev}_i+\beta_{\mathrm{DP},4}^{\mathrm{del}}\mathrm{TV}_i+\beta_{\mathrm{DP},5}^{\mathrm{del}}\mathrm{IV}_i+\varepsilon_{\mathrm{DP},i}^{\mathrm{del}},\\
\mathrm{CF}_{n,i}^{\mathrm{del}} &= \beta_{\mathrm{CF},0}^{\mathrm{del}}+\beta_{\mathrm{CF},1}^{\mathrm{del}}\mathrm{Call}_i+\beta_{\mathrm{CF},2}^{\mathrm{del}}\mathrm{Size}_i+\beta_{\mathrm{CF},3}^{\mathrm{del}}\mathrm{Lev}_i+\beta_{\mathrm{CF},4}^{\mathrm{del}}\mathrm{TV}_i+\beta_{\mathrm{CF},5}^{\mathrm{del}}\mathrm{IV}_i+\varepsilon_{\mathrm{CF},i}^{\mathrm{del}}.
\end{aligned} \tag{8*}$$

Stage 2

$$\begin{aligned}
\mathrm{PL}_i^{\mathrm{ind}} &= \alpha_0^{\mathrm{ind}} + \alpha_1^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{ind}} + \alpha_2^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{ind}} + \alpha_3^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{ind}} + \alpha_4^{\mathrm{ind}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{ind}} + \varepsilon_{\mathrm{PL},i}^{\mathrm{ind}},\\
\mathrm{PL}_i^{\mathrm{del}} &= \alpha_0^{\mathrm{ind}} + \alpha_1^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{del}} + \alpha_2^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{del}} + \alpha_3^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{DP},i}^{\mathrm{del}} + \alpha_4^{\mathrm{del}}\hat{\varepsilon}_{\mathrm{CF},i}^{\mathrm{del}} + \varepsilon_{\mathrm{PL},i}^{\mathrm{del}}.
\end{aligned}$$

For brevity, we only report the empirical results of Stage 2 since the relations among coefficients of disposition and coefficients of confidence and warrant characteristics have been presented in the previous sections. We present parameter estimates and the corresponding t values in parentheses by fitting the data with GMM, and the symbols $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% level, respectively.

5. Reexamination and Robustness Analysis

5.1. Mediation analysis of disposition and confidence in warrant and spot markets

In Section 4.3, we find that there are positive linkages with cross-market spillover effects on coefficients of disposition and coefficients of confidence between spot markets and the corresponding warrant markets. In addition, we find that coefficients of disposition and coefficients of confidence in warrants' markets influence on PL of individual investors and dealers in Section 4.4. Accordingly, we analyze coefficients of disposition and coefficients of confidence in spot markets, coefficients of disposition and coefficients of confidence in their corresponding warrant markets, and PL through the steps proposed by Baron and Kenny [9] to directly explore of the impacts of coefficients of disposition and coefficients of confidence in spot markets on PL in warrant markets. Thus, we will not only be able to better understand the relations among coefficients of disposition, coefficients of confidence, and PL, but also investigate the extent of coefficients of disposition and coefficients of confidence in underlying stock markets as mediators working their way through coefficients of disposition and coefficients of confidence in warrant markets to influence PL.

In accordance with Baron and Kenny [9], the first step of our mediation analysis is to regress the mediator variables, i.e., coefficients of disposition and coefficients of confidence in underlying stock markets against coefficients of disposition and coefficients of confidence in warrant markets, and the regression specifications are:

$$\mathrm{UDP}_{v,i}^{\mathrm{ind}} = \lambda_0 + \lambda_1\mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2\mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3\mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4\mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{9}$$

$$\mathrm{UCF}_{v,i}^{\mathrm{ind}} = \lambda_0 + \lambda_1\mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2\mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3\mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4\mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{10}$$

$$\mathrm{UDP}_{v,i}^{\mathrm{del}} = \lambda_0 + \lambda_1\mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2\mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3\mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4\mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{11}$$

$$\mathrm{UCF}^{\mathrm{del}}_{v,i} = \lambda_0 + \lambda_1 \mathrm{DP}^{\mathrm{ind}}_{v,i} + \lambda_2 \mathrm{CF}^{\mathrm{ind}}_{v,i} + \lambda_3 \mathrm{DP}^{\mathrm{del}}_{v,i} + \lambda_4 \mathrm{CF}^{\mathrm{del}}_{v,i} + \varepsilon_{\mathrm{del},i}. \tag{12}$$

Panel A of Table 6 reveals that coefficients of disposition and coefficients of confidence are significantly related to mediator variables as evidenced by $\hat{\lambda}_1$ in equations (9), (10) and (11), $\hat{\lambda}_2$ in equation (12), $\hat{\lambda}_3$ in equations (9) and (11) and $\hat{\lambda}_4$ in equation (12) being significant at the 1% level. Subsequently, we examine the significance of the impacts of coefficients of disposition and coefficients of confidence on PL, and the regression specifications are:

$$\mathrm{PL}^{\mathrm{ind}}_{i} = \alpha_0 + \alpha_1 \mathrm{DP}^{\mathrm{ind}}_{v,i} + \alpha_2 \mathrm{CF}^{\mathrm{ind}}_{v,i} + \alpha_3 \mathrm{DP}^{\mathrm{del}}_{v,i} + \alpha_4 \mathrm{CF}^{\mathrm{del}}_{v,i} + \varepsilon_{\mathrm{ind},i}, \tag{13}$$

$$\mathrm{PL}^{\mathrm{del}}_{i} = \alpha_0 + \alpha_1 \mathrm{DP}^{\mathrm{ind}}_{v,i} + \alpha_2 \mathrm{CF}^{\mathrm{ind}}_{v,i} + \alpha_3 \mathrm{DP}^{\mathrm{del}}_{v,i} + \alpha_4 \mathrm{CF}^{\mathrm{del}}_{v,i} + \varepsilon_{\mathrm{del},i}. \tag{14}$$

The empirical results of Panel B of Table 6 demonstrate that coefficients of disposition of individual investors and dealers are significantly related to PL as evidenced by $\hat{\alpha}_1$, $\hat{\alpha}_3$ and $\hat{\alpha}_4$ being significant at the 1% level , with the adjusted R-squared being 5.812% and coefficient of confidence of dealers is significantly related to PL as evidenced by $\hat{\alpha}_4$ being significant at the 1% level, with the adjusted R-squared being 5.772%.

At last, we add coefficients of disposition and coefficients of confidence in underlying stock markets, $\mathrm{UDP}^{\mathrm{ind}}$, $\mathrm{UCF}^{\mathrm{ind}}$, $\mathrm{UDP}^{\mathrm{del}}$, and $\mathrm{UCF}^{\mathrm{del}}$ to equations (13) and (14) as additional explanatory variables to understand the extent of coefficients of disposition and coefficients of confidence in underlying stock markets as mediation of coefficients of disposition and coefficients of confidence in warrant markets. Accordingly, the regression specifications are:

$$\begin{aligned}\mathrm{PL}^{\mathrm{ind}}_{i} = {} & \alpha_0 + \alpha_1 \mathrm{DP}^{\mathrm{ind}}_{v,i} + \alpha_2 \mathrm{CF}^{\mathrm{ind}}_{v,i} + \alpha_3 \mathrm{DP}^{\mathrm{del}}_{v,i} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\ & + \tau_1 \mathrm{UDP}^{\mathrm{ind}}_{v,i} + \tau_2 \mathrm{UCF}^{\mathrm{ind}}_{v,i} + \tau_3 \mathrm{UDP}^{\mathrm{del}}_{v,i} + \tau_4 \mathrm{UCF}^{\mathrm{del}}_{v,i} + \varepsilon_{\mathrm{ind},i}, \end{aligned} \tag{15}$$

$$\begin{aligned}\mathrm{PL}^{\mathrm{del}}_{i} = {} & \alpha_0 + \alpha_1 \mathrm{DP}^{\mathrm{ind}}_{v,i} + \alpha_2 \mathrm{CF}^{\mathrm{ind}}_{v,i} + \alpha_3 \mathrm{DP}^{\mathrm{del}}_{v,i} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\ & + \tau_1 \mathrm{UDP}^{\mathrm{ind}}_{v,i} + \tau_2 \mathrm{UCF}^{\mathrm{ind}}_{v,i} + \tau_3 \mathrm{UDP}^{\mathrm{del}}_{v,i} + \tau_4 \mathrm{UCF}^{\mathrm{del}}_{v,i} + \varepsilon_{\mathrm{del},i}. \end{aligned} \tag{16}$$

Comparing equation (15) with equation (13), and equation (16) with equation (14), the results in Panel B and Panel C of Table 6 reveal similar significance in these paired equations. In addition, the adjusted R-squared increases from 5.812% in equation (13) to 6.336% in equation (15), as well as 5.772% in equation (16) to 6.271% in equation (14). However, we find that only $\hat{\tau}_1$ and $\hat{\tau}_2$ are significant at the 1% level, indicating that only individual investors' coefficient of disposition and coefficient of confidence work as mediator variables. Moreover, $\mathrm{UOC}^{\mathrm{ind}}$ is likely to play as a particularly important role, since $\hat{\tau}_2$ is significantly negative, while $\hat{\alpha}_2$ is insignificant at the 1% significance level in equation (15), implying that individual investors' coefficient of confidence in the corresponding underlying stock market has an impact on PL in warrants.

Finally, we obtain similar results after repeating the same procedures to investigate of mediation effects by substituting coefficients of disposition and coefficients of confidence in number of transactions for coefficients of disposition and coefficients of confidence in volume in models (9), (10), (11), (12), (13), (14), (15) and (16) yield equations (9*), (10*), (11*), (12*), (13*), (14*), (15*) and (16*), i.e.,

$$\mathrm{UDP}^{\mathrm{ind}}_{n,i} = \lambda_0 + \lambda_1 \mathrm{DP}^{\mathrm{ind}}_{v,i} + \lambda_2 \mathrm{CF}^{\mathrm{ind}}_{v,i} + \lambda_3 \mathrm{DP}^{\mathrm{del}}_{v,i} + \lambda_4 \mathrm{CF}^{\mathrm{del}}_{v,i} + \varepsilon_{\mathrm{ind},i}, \tag{9*}$$

$$\begin{aligned}
\mathrm{UCF}_{n,i}^{\mathrm{ind}} &= \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, && (10^*)\\
\mathrm{UDP}_{n,i}^{\mathrm{del}} &= \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, && (11^*)\\
\mathrm{UCF}_{n,i}^{\mathrm{del}} &= \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, && (12^*)\\
\mathrm{PL}_{i}^{\mathrm{ind}} &= \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, && (13^*)\\
\mathrm{PL}_{i}^{\mathrm{del}} &= \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, && (14^*)\\
\mathrm{PL}_{i}^{\mathrm{ind}} &= \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\
&\quad + \tau_1 \mathrm{UDP}_{n,i}^{\mathrm{ind}} + \tau_2 \mathrm{UCF}_{n,i}^{\mathrm{ind}} + \tau_3 \mathrm{UDP}_{n,i}^{\mathrm{del}} + \tau_4 \mathrm{UCF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} && (15^*)\\
\mathrm{PL}_{i}^{\mathrm{del}} &= \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\
&\quad + \tau_1 \mathrm{UDP}_{n,i}^{\mathrm{ind}} + \tau_2 \mathrm{UCF}_{n,i}^{\mathrm{ind}} + \tau_3 \mathrm{UDP}_{n,i}^{\mathrm{del}} + \tau_4 \mathrm{UCF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i} && (16^*)
\end{aligned}$$

Table 6: Mediation Analysis of Coefficient of Disposition and Coefficient of Confidence on Profits and Losses.

Note: In Table 6, we conduct the mediation analysis (Baron and Kenny [9]) to examine the impacts of coefficients of disposition and coefficients of confidence in underlying stocks markets on PL of warrants. First, Panel A presents the results of the regressions of coefficients of disposition and coefficients of confidence in warrants' markets against those coefficients in underlying stocks' markets, and the regression specifications are:

$$\mathrm{UDP}_{v,i}^{\mathrm{ind}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{9}$$

$$\mathrm{UCF}_{v,i}^{\mathrm{ind}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{10}$$

$$\mathrm{UDP}_{v,i}^{\mathrm{del}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{11}$$

$$\mathrm{UCF}_{v,i}^{\mathrm{del}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{12}$$

In addition, Panel B presents the regression of PL against coefficients of disposition and coefficients of confidence of individual investors and dealers, and the regression specifications are:

$$\mathrm{PL}_{i}^{\mathrm{ind}} = \alpha_0 + \alpha_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{13}$$

$$\mathrm{PL}_{i}^{\mathrm{del}} = \alpha_0 + \alpha_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{14}$$

Finally, we add the coefficients of disposition and coefficients of confidence in underlying stocks markets to equations (12) and (13) as additional explanatory variables to verify their extent as mediation of coefficients of disposition and coefficients of confidence in warrants markets, and the regression specifications are:

$$\begin{aligned}\mathrm{PL}_{i}^{\mathrm{ind}} = {}& \alpha_0 + \alpha_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\ & + \tau_1 \mathrm{UDP}_{v,i}^{\mathrm{ind}} + \tau_2 \mathrm{UCF}_{v,i}^{\mathrm{ind}} + \tau_3 \mathrm{UDP}_{v,i}^{\mathrm{del}} + \tau_4 \mathrm{UCF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}\end{aligned} \tag{15}$$

$$\begin{aligned}\mathrm{PL}_{i}^{\mathrm{del}} = {}& \alpha_0 + \alpha_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\ & + \tau_1 \mathrm{UDP}_{v,i}^{\mathrm{ind}} + \tau_2 \mathrm{UCF}_{v,i}^{\mathrm{ind}} + \tau_3 \mathrm{UDP}_{v,i}^{\mathrm{del}} + \tau_4 \mathrm{UCF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}\end{aligned} \tag{16}$$

Correspondingly, we apply the same procedures for measures coefficients of disposition and coefficients of confidence in number of transactions, i.e.,

$$\mathrm{UDP}_{n,i}^{\mathrm{ind}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{9*}$$

$$\mathrm{UCF}_{n,i}^{\mathrm{ind}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{10*}$$

$$\mathrm{UDP}_{n,i}^{\mathrm{del}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{11*}$$

$$\mathrm{UCF}_{n,i}^{\mathrm{del}} = \lambda_0 + \lambda_1 \mathrm{DP}_{v,i}^{\mathrm{ind}} + \lambda_2 \mathrm{CF}_{v,i}^{\mathrm{ind}} + \lambda_3 \mathrm{DP}_{v,i}^{\mathrm{del}} + \lambda_4 \mathrm{CF}_{v,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{12*}$$

$$\mathrm{PL}_{i}^{\mathrm{ind}} = \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}, \tag{13*}$$

$$\mathrm{PL}_{i}^{\mathrm{del}} = \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}, \tag{14*}$$

$$\begin{aligned}\mathrm{PL}_{i}^{\mathrm{ind}} = {}& \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\ & + \tau_1 \mathrm{UDP}_{n,i}^{\mathrm{ind}} + \tau_2 \mathrm{UCF}_{n,i}^{\mathrm{ind}} + \tau_3 \mathrm{UDP}_{n,i}^{\mathrm{del}} + \tau_4 \mathrm{UCF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i}\end{aligned} \tag{15*}$$

$$\begin{aligned}\mathrm{PL}_{i}^{\mathrm{del}} = {}& \alpha_0 + \alpha_1 \mathrm{DP}_{n,i}^{\mathrm{ind}} + \alpha_2 \mathrm{CF}_{n,i}^{\mathrm{ind}} + \alpha_3 \mathrm{DP}_{n,i}^{\mathrm{del}} + \alpha_4 \mathrm{CF}^{\mathrm{del}} + \varepsilon_{\mathrm{ind},i} \\ & + \tau_1 \mathrm{UDP}_{n,i}^{\mathrm{ind}} + \tau_2 \mathrm{UCF}_{n,i}^{\mathrm{ind}} + \tau_3 \mathrm{UDP}_{n,i}^{\mathrm{del}} + \tau_4 \mathrm{UCF}_{n,i}^{\mathrm{del}} + \varepsilon_{\mathrm{del},i}\end{aligned} \tag{16*}$$

We present parameter estimates and the corresponding t values in parentheses by fitting the data with GMM, and the symbols $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 6. Mediation Analysis of Coefficient of Disposition and Coefficient of Confidence on Profits and Losses (cont.)

Panel A. In Trading Volume, Step 1									
$\mathrm{UDE}_{v,i}^{\mathrm{ind}}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.100***	0.045***	-0.005	0.064***	-0.028**				
t value	74.554	4.544	-0.434	5.285	-2.417				
Adjusted R-squared 4.756%									
$\mathrm{UOC}_{v,i}^{\mathrm{ind}}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.019***	0.029***	0.012	0.029**	0.022*				
t value	12.290	2.601	0.949	2.027	1.704				
Adjusted R-squared 4.667%									
$\mathrm{UDE}_{v,i}^{\mathrm{del}}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.026***	0.075***	-0.032*	0.068***	-0.044**				
t value	12.062	4.619	-1.947	3.502	-2.309				
Adjusted R-squared 1.680%									
$\mathrm{UOC}_{v,i}^{\mathrm{del}}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.067***	-0.004	0.054***	0.008	0.045***				
t value	39.844	-0.303	4.154	0.533	2.916				
Adjusted R-squared 4.548%									
Panel B. In Trading Volume, Step 2									
$\mathrm{PL}_i^{\mathrm{ind}}$	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$				
Estimate	-707.16***	1982.60***	-39.49	724.57***	-723.14***				
t value	-21.946	11.061	-0.240	3.969	-3.816				
Adjusted R-squared 5.812%									
$\mathrm{PL}_i^{\mathrm{del}}$	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$				
Estimate	710.88***	-1973.70***	40.259	-724.580***	715.260***				
t value	22.018	-10.960	0.245	-3.973	3.757				
Adjusted R-squared 5.772%									
Panel C. In Trading Volume, Step 3									
$\mathrm{PL}_i^{\mathrm{ind}}$	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\tau}_1$	$\hat{\tau}_2$	$\hat{\tau}_3$	$\hat{\tau}_4$
Estimate	-912.91***	1901.90***	21.29	600.09***	-584.70***	2621.60***	-1759.80***	154.12	-416.75
t value	-15.565	10.665	0.131	3.334	-3.100	6.547	-4.808	0.709	-1.562
Adjusted R-squared 6.336%									
$\mathrm{PL}_i^{\mathrm{del}}$	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\tau}_1$	$\hat{\tau}_2$	$\hat{\tau}_3$	$\hat{\tau}_4$
Estimate	913.77***	-1894.80***	-18.75	-602.43***	580.01***	-2582.00***	1719.50***	-138.76	405.66
t value	15.534	-10.574	-0.115	-3.348	3.062	-6.430	4.680	-0.636	1.516
Adjusted R-squared 6.271%									

Table 6. Mediation Analysis of Coefficient of Disposition and Coefficient of Confidence on Profits and Losses (cont.)

Panel D. In Number of Transactions, Step 1									
$\text{UDE}^{\text{ind}}_{n,i}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.082***	0.062***	-0.038***	0.101***	-0.043***				
t value	66.563	5.377	-2.784	6.799	-3.272				
Adjusted R-squared 5.371%									
$\text{UOC}^{\text{ind}}_{n,i}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.008***	0.047***	0.018	0.035**	0.002				
t value	5.511	3.849	1.308	2.314	0.126				
Adjusted R-squared 5.549%									
$\text{UDE}^{\text{del}}_{n,i}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.007***	0.087***	-0.047**	0.090***	-0.056**				
t value	3.204	4.393	-2.037	3.521	-2.534				
Adjusted R-squared 1.780%									
$\text{UOC}^{\text{del}}_{n,i}$	$\hat{\lambda}_0$	$\hat{\lambda}_1$	$\hat{\lambda}_2$	$\hat{\lambda}_3$	$\hat{\lambda}_4$				
Estimate	0.063***	0.012	0.012	0.058***	0.021				
t value	41.054	0.832	0.739	3.266	1.317				
Adjusted R-squared 4.580%									
Panel E. In Number of Transactions, Step 2									
PL^{ind}_i	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$				
Estimate	-703.04***	3272.50***	-650.10**	1641.50***	-2068.80***				
t value	-21.310	10.831	-2.401	5.516	-6.568				
Adjusted R-squared 6.421%									
PL^{del}_i	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$				
Estimate	-703.04***	3272.50***	-650.10**	1641.50***	-2068.80***				
t value	21.377	-10.747	2.388	-5.510	6.523				
Adjusted R-squared 6.382%									
Panel F. In Number of Transactions, Step 3									
PL^{ind}_i	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\tau}_1$	$\hat{\tau}_2$	$\hat{\tau}_3$	$\hat{\tau}_4$
Estimate	-703.04***	3272.50***	-650.10**	1641.50***	-2068.80***				
t value	-21.310	10.831	-2.401	5.516	-6.568				
Adjusted R-squared 6.421%									
PL^{ind}_i	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\tau}_1$	$\hat{\tau}_2$	$\hat{\tau}_3$	$\hat{\tau}_4$
Estimate	-871.47***	3193.40***	-510.66*	1454.70***	-1945.30***	2339.50***	-1888.70***	293.24	-177.95
t value	-14.545	10.529	-1.906	4.972	-6.153	5.876	-4.635	1.256	-0.504
Adjusted R-squared 6.861%									
PL^{del}_i	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\tau}_1$	$\hat{\tau}_2$	$\hat{\tau}_3$	$\hat{\tau}_4$
Estimate	872.55***	-3194.20***	508.25*	-1451.40***	1949.40***	-2308.00***	1836.30***	-272.45	180.22
t value	14.513	-10.455	1.902	-4.975	6.122	-5.784	4.484	-1.161	0.509
Adjusted R-squared 6.799%									

5.3. Robustness tests

For robustness, we re-estimate coefficients of disposition and coefficients of confidence by respectively controlling the magnitudes of positive daily return and negative daily return during the studying period because investors' trading volumes are likely to be affected by momentum and/or reversal effects (see e.g., Daniel et al. [18] and Daniel et al. [19]; Glaser and Weber [28]), and further examine whether such estimates significantly change our empirical results. To this end, for each warrant, we respectively define the proxies of momentum and reversal effects as:

$$\mathrm{MT}_i = \sum_{r_1,t>0}^{T} |r_{i,t}|, \tag{17}$$

$$\mathrm{RV}_i = \sum_{r_1,t<0}^{T} |r_{i,t}|, \tag{18}$$

where MT_i and RV_i are the magnitudes of momentum and reversal effects for warrant i, respectively; $r_{i,t}$ is the daily return of underlying stock of warrant i on trading day t. In other words, MT_i (RV_i) is the sum of the absolute value of positive (negative) daily returns during the studying period. Accordingly, we use an instrumental variable approach in the regression analysis to control the momentum and contrarian effects. First, we obtain R_DP and R_CF, which are the residual values of DP and CF of individual investors and dealers in volume and in number of transactions respectively from the following regressions (19), (20), (21), (22), (19*), (20*), (21*) and (22*) in which the interaction terms Call·MT and Call·RV are included to verify whether there is asymmetry towards MT and RV on call and put warrants, i.e.,

$$\mathrm{DP}^{\mathrm{ind}}_{v,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{19}$$

$$\mathrm{DP}^{\mathrm{del}}_{v,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{20}$$

$$\mathrm{CF}^{\mathrm{ind}}_{v,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i, \tag{21}$$

$$\mathrm{CF}^{\mathrm{del}}_{v,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i, \tag{22}$$

$$\mathrm{DP}^{\mathrm{ind}}_{n,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{19*}$$

$$\mathrm{DP}^{\mathrm{del}}_{n,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{20*}$$

$$\mathrm{CF}^{\mathrm{ind}}_{n,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i, \tag{21*}$$

$$\mathrm{CF}^{\mathrm{del}}_{n,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i. \tag{22*}$$

Subsequently, we fit regressions (4), (5), (6), (7), (4*), (5*), (6*) and (7*), by replacing the dependent variables with R_DP$^{\mathrm{ind}}_{v,i}$, R_DP$^{\mathrm{del}}_{v,i}$, R_CF$^{\mathrm{ind}}_{v,i}$, R_CF$^{\mathrm{del}}_{v,i}$, R_DP$^{\mathrm{ind}}_{n,i}$, R_DP$^{\mathrm{del}}_{n,i}$, R_CF$^{\mathrm{ind}}_{n,i}$, and R_CF$^{\mathrm{del}}_{n,i}$, and we obtain (4R), (5R), (6R), (7R), (4R*), (5R*), (6R*) and (7R*). Accordingly, Table 7 reveals the results of our robustness tests by using instrumental variable approach in the regression analysis to control the momentum and contrarian effects. First, we find that DP and CF of individual investors and dealers in volume and in number of transactions are significantly influenced by MT and RV as evidenced by all the estimated coefficients being significant at the 1% level in (19), (19*), (20), (20*), (21), (21*), (22), and (22*), indicating that momentum and reversal effects are both crucial for coefficients of disposition and coefficients of confidence. Second, the empirical results in models with an instrumental variable demonstrate similar patterns with their corresponding models, with less significance. In sum, the above robustness tests illustrate that, the dependent variables after controlling the momentum and reversal effects yield very similar results.

Table 7: Robustness Tests.

Note: In Table 7, we re-estimate coefficients of disposition and coefficients of confidence by controlling the accumulated magnitudes of positive daily returns and negative daily returns, and further examine whether such estimates significantly change our empirical results. For each warrant, we respectively define the proxies of momentum and contrarian effects as:

$$\mathrm{MT}_i = \sum_{r_1, t>0}^{T} |r_{i,t}|, \tag{17}$$

$$\mathrm{RV}_i = \sum_{r_1, t<0}^{T} |r_{i,t}|. \tag{18}$$

Accordingly, we use an instrumental variable approach in the regression analysis to control the momentum and contrarian effects. First, we obtain R_DP and R_CF, which are the residual values of DP and CF of individual investors and dealers in volume and in number of transactions respectively from the following regressions (19), (20), (21), (22), (19*), (20*), (21*), and (22*) in which the interaction terms Call·MT and Call·RV are included to verify whether there is asymmetry towards MT and RV on call and put warrants.

$$\mathrm{DP}^{\mathrm{ind}}_{v,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{19}$$

$$\mathrm{DP}^{\mathrm{del}}_{v,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{20}$$

$$\mathrm{CF}^{\mathrm{ind}}_{v,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i, \tag{21}$$

$$\mathrm{CF}^{\mathrm{del}}_{v,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i, \tag{22}$$

$$\mathrm{DP}^{\mathrm{ind}}_{n,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{19*}$$

$$\mathrm{DP}^{\mathrm{del}}_{n,i} = \alpha_{\mathrm{DP}} + \beta_{\mathrm{DP},1}\mathrm{MT}_{ii} + \beta_{\mathrm{DP},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{DP},1}\mathrm{RV} + \gamma_{\mathrm{DP},2}\mathrm{RV}_i + \varepsilon_i, \tag{20*}$$

$$\mathrm{CF}^{\mathrm{ind}}_{n,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i, \tag{21*}$$

$$\mathrm{CF}^{\mathrm{del}}_{n,i} = \alpha_{\mathrm{CF}} + \beta_{\mathrm{CF},1}\mathrm{MT}_{ii} + \beta_{\mathrm{CF},2}\mathrm{Call}_i \cdot \mathrm{MT}_i + \gamma_{\mathrm{CF},1}\mathrm{RV}_{ii} + \gamma_{\mathrm{CF},2}\mathrm{RV} + \varepsilon_i. \tag{22*}$$

Subsequently, we fit regressions (4), (5), (6), (7), (4*), (5*), (6*), and (7*) by replacing the dependent variables with R_DP$^{\mathrm{ind}}_{v,i}$, R_DP$^{\mathrm{del}}_{v,i}$, R_CF$^{\mathrm{ind}}_{v,i}$, R_CF$^{\mathrm{del}}_{v,i}$, R_DP$^{\mathrm{ind}}_{n,i}$, R_DP$^{\mathrm{del}}_{n,i}$, R_CF$^{\mathrm{ind}}_{n,i}$, and R_CF$^{\mathrm{del}}_{n,i}$, and obtain (4R), (5R), (6R), (7R), (4R*), (5R*), (6R*), and (7R*). The estimated parameter and the corresponding t value in parentheses are presented. We present parameter estimates and the corresponding t values by fitting the data with GMM, and the symbols $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 7. Robustness Tests (cont.).

Panel A. Coefficient of Disposition					
Individual Investors			Dealers		
	Model (19)	Model (19*)		Model (20)	Model (20*)
$\hat{\alpha}_{\mathrm{DP}}$	0.240***	0.210***	$\hat{\alpha}_{\mathrm{DP}}$	0.135***	0.138***
	(17.913)	(17.981)		(9.925)	(11.949)
$\hat{\beta}_{\mathrm{DP},1}$	-0.413***	-0.363***	$\hat{\beta}_{\mathrm{DP},1}$	-0.385***	-0.397***
	(-14.855)	(-14.220)		(-13.607)	(-14.920)
$\hat{\beta}_{\mathrm{DP},2}$	0.643***	0.558***	$\hat{\beta}_{\mathrm{DP},2}$	0.567***	0.588***
	(20.426)	(19.438)		(17.381)	(19.161)
$\hat{\gamma}_{\mathrm{DP},1}$	0.389***	0.361***	$\hat{\gamma}_{\mathrm{DP},1}$	0.359***	0.377***
	(12.825)	(12.931)		(11.592)	(12.875)
$\hat{\gamma}_{\mathrm{DP},2}$	-0.638***	-0.573***	$\hat{\gamma}_{\mathrm{DP},2}$	-0.601***	-0.631***
	(-18.478)	(-18.109)		(-16.829)	(-18.762)
Adjusted R-squared	8.495%	7.412%	Adjusted R-squared	6.175%	8.667%
	Model (4R)	Model (4R*)		Model (5R)	Model (5R*)
$\hat{\beta}_0^{\mathrm{ind}}$	0.281***	0.351***	$\hat{\beta}_0^{\mathrm{del}}$	0.352***	0.459***
	(4.106)	(5.494)		(5.170)	(8.215)
$\hat{\beta}_1^{\mathrm{ind}}$	0.010	0.003	$\hat{\beta}_1^{\mathrm{del}}$	0.009	0.000
	(1.039)	(0.406)		(0.996)	(0.039)
$\hat{\beta}_2^{\mathrm{ind}}$	-0.026***	-0.029***	$\hat{\beta}_2^{\mathrm{del}}$	-0.024***	-0.030***
	(-7.076)	(-8.628)		(-6.427)	(-9.790)
$\hat{\beta}_3^{\mathrm{ind}}$	0.030***	0.027***	$\hat{\beta}_3^{\mathrm{del}}$	0.020***	0.023***
	(12.418)	(12.571)		(7.700)	(10.739)
$\hat{\beta}_4^{\mathrm{ind}}$	-0.010-0.013*	$\hat{\beta}_4^{\mathrm{del}}$	0.007	-0.007	
	(-1.206)	(-1.884)		(0.854)	(-0.985)
$\hat{\beta}_5^{\mathrm{ind}}$	0.127***	0.074**	$\hat{\beta}_5^{\mathrm{del}}$	-0.035	-0.033
	(4.077)	(2.157)		(-1.056)	(-1.294)
$\hat{\beta}_6^{\mathrm{ind}}$	0.241***	0.321***	$\hat{\beta}_6^{\mathrm{del}}$	0.096***	0.112***
	(5.775)	(7.632)		(2.961)	(4.291)
Adjusted R-squared	2.657%	3.029%	Adjusted R-squared	1.261%	2.194%

Panel B. Coefficient of Confidence					
Individual Investors			Dealers		
	Model (21)	Model (21*)		Model (22)	Model (22*)
$\hat{\alpha}_{\mathrm{CF}}$	0.119***	0.121***	$\hat{\alpha}_{\mathrm{CF}}$	0.222***	0.202***
	(8.532)	(10.378)		(17.497)	(17.915)
$\hat{\beta}_{\mathrm{CF},1}$	-0.348***	-0.376***	$\hat{\beta}_{\mathrm{CF},1}$	-0.428***	-0.362***
	(-11.518)	(-13.808)		(-15.662)	(-14.591)
$\hat{\beta}_{\mathrm{CF},2}$	0.508***	0.552***	$\hat{\beta}_{\mathrm{CF},2}$	0.625***	0.532***
	(14.710)	(17.851)		(20.099)	(18.890)
$\hat{\gamma}_{\mathrm{CF},1}$	0.325***	0.366***	$\hat{\gamma}_{\mathrm{CF},1}$	0.409***	0.357***
	(9.843)	(12.205)		(13.779)	(13.196)
$\hat{\gamma}_{\mathrm{CF},2}$	-0.550***	-0.601***	$\hat{\gamma}_{\mathrm{CF},2}$	-0.620***	-0.541***
	(-14.579)	(-17.686)		(-18.150)	(-17.616)
Adjusted R-squared	4.693%	7.115%	Adjusted R-squared	8.587%	7.112%

Table 7. Robustness Tests (cont.).

	Model (6R)	Model (6R*)		Model (7R)	Model (7R*)
$\hat{\beta}_0^{\text{ind}}$	0.255***	0.362***	$\hat{\beta}_0^{\text{del}}$	0.247***	0.326***
	(3.514)	(6.131)		(3.902)	(5.454)
$\hat{\beta}_1^{\text{ind}}$	0.005	-0.004	$\hat{\beta}_1^{\text{del}}$	0.008	0.002
	(0.519)	(-0.414)		(0.887)	(0.271)
$\hat{\beta}_2^{\text{ind}}$	-0.017***	-0.023***	$\hat{\beta}_2^{\text{del}}$	-0.023***	-0.025***
	(-4.342)	(-7.215)		(-6.796)	(-8.216)
$\hat{\beta}_3^{\text{ind}}$	0.016***	0.020***	$\hat{\beta}_3^{\text{del}}$	0.026***	0.022***
	(6.060)	(8.991)		(11.353)	(10.943)
$\hat{\beta}_4^{\text{ind}}$	-0.002	-0.008	$\hat{\beta}_4^{\text{del}}$	-0.009	-0.005
	(-0.251)	(-1.173)		(-1.136)	(-0.732)
$\hat{\beta}_5^{\text{ind}}$	-0.042	-0.044	$\hat{\beta}_5^{\text{del}}$	0.124***	0.056*
	(-1.197)	(-1.629)		(4.135)	(1.798)
$\hat{\beta}_6^{\text{ind}}$	0.302***	0.334***	$\hat{\beta}_6^{\text{del}}$	0.212***	0.241***
	(7.470)	(9.345)		(7.280)	(7.860)
Adjusted R-squared	2.103%	3.453%	Adjusted R-squared	3.313%	3.071%

6. Conclusions

Recently, the behavioral finance literature has paid increasing attention to understanding the behavioral biases, disposition effects and overconfidence. In this study, we demonstrate the extent on a warrant's characteristics influence its coefficients of disposition, coefficients of confidence, and PL through regression and mediation analyses. By assembling a unique dataset of listed warrants on the TWSE, we show that warrants' characteristics have similar influence upon coefficients of disposition and coefficients of confidence of individual investors and dealers. Both individual investors and dealers tend to realize their profits, and less confident on the warrants whose underlying stocks in relatively small scale, indicating that transparency and information asymmetry are likely to influence individual investor and dealers' behaviors. In addition, there are positive linkages with cross-market spillover effects on levels of disposition coefficients and level of confidence between spot markets and the corresponding warrant markets. However, coefficients of disposition as well as coefficients of confidence of individual investors and dealers are opposite towards implied volatility. Individual investors are less confident and tend to realize profits on warrants with higher implied volatility, while dealers *per contra*.

We also show that, although all coefficients of disposition and coefficients of confidence have considerable impacts on PL by separate groups of investors, cross-market spillover effects on levels of disposition and levels of confidence of individual investors from spot markets are especially important to contribute to PL of individual investors and dealers.

In conclusion, our findings indicate the importance of the levels of disposition and levels of confidence on PL of both types of investors. Accordingly, our novel discoveries on how a warrant's characteristics affect coefficients of disposition and coefficients of confidence, and how coefficients of disposition and coefficients of confidence affect PL could shed some light on better understanding of investors' behavioral biases. As a result, since dealers and individual investors' attitudes are similar in some aspects but different in other aspects toward trading warrants, regulators may reconsider the role that warrants play in financial markets, during the recent periods with more and more uncertAindy.

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