Overconfidence Behavior and Disposition Effect of Investors in Taiwan Stock Market: Another Features to Visit

Hsiang-Hsi Liu *, Fei-Jen Kan
Graduate Institute of International Business, National Taipei University, Taiwan

*Corresponding author: hsiang@mail.ntpu.edu.tw

Received June 29, 2021; Revised August 01, 2021; Accepted August 09, 2021

Abstract This research specifically incorporates the impact of the disposition effect of trading volume into the model construction to more accurately verify the overconfidence behavior of investors in the Taiwan stock market. Based on the theoretical framework and related literature of overconfidence and disposition behavior, we propose the hypothesis to be test and further uses Taiwan stock price index with a turnover rate and return rate after removing the weekly effect for about ten-year data, and construct a tri-variate VAR-GARCH model to examine the investor overconfidence behavior and disposition effect of Taiwan stock market. The empirical results indicate that investors in the Taiwan stock market do have a tendency to overconfidence and are easily affected by the market environment. According to the risk of market capitalization, overconfident investors are not necessarily inclined to hold higher risk stocks. In addition to overconfidence behavior, investors in the Taiwan stock market also have a significant disposition effect, indicating that investors cannot rationally judge the timing of selling or purchasing their stocks. By recognizing this relationship and analyzing the biased trends from overconfidence and disposition effect in trading volumes and returns, such knowledge can help the investors/practitioners to develop strategies and take appropriate measures.

Keywords: overconfidence behavior, disposition effect, prospect theory, behavioral finance, VAR-GARCH model

Cite This Article: Hsiang-Hsi Liu, and Fei-Jen Kan, “Overconfidence Behavior and Disposition Effect of Investors in Taiwan Stock Market: Another Features to Visit.” Journal of Finance and Economics, vol. 9, no. 5 (2021): 170-183. doi: 10.12691/jfe-9-5-2.

1. Introduction

In 1973, there were only 62 listed companies on the Taiwan stock market, and the amount of total annual stock transaction about NT$87 billion, but by the end of 2019, the number of listed companies has grown more than tenfold to a total of 942 companies, and the total annual transaction amount is as high as NT$26.37 trillion (US$86.50 billion) (Source: Taiwan Stock Exchange). According to these data, the Taiwan stock market is growing rapidly, and the amount of investment injected into the stock market is also increasing day by day. With the growth of the stock market, the number of investors participating in the stock market has also increased, and the irrational investment behaviors of investors have become more and more obvious, such as investors chasing ups and downs, weekend effects, and even the so-called "pre-election market", etc. Prove that investors are not completely rational. In addition, apart from the traditional hedging and liquidity requirements, the huge trading volume today is believed to be partly attributable to investors’ overconfidence behavior or disposition effect. This is what we will explore the issues in this study.

Human beings are often overconfident in their abilities, knowledge and future prospects. Odean [1] showed that overconfident investors trade more than rational investors, which reduces their expected utility. Overconfidence leads to more trading and lower expected utility. When investors have overconfidence, their investment behavior will become more positive (aggressive) due to past investment profits, and due to overestimation of self-ability, that is, self-attribution bias, it is easy to cause to neglect the risk, holding too many high-risk stocks, or because of too many transactions, the profit of investment is eroded by transaction costs and reduced, these are all the damages caused by overconfidence to investors (Statman, Thorley and Vorkink [2]; Chuang and Lee [3]; Ho [4] and Liu, Chuang, Huang and Chen [5]). Therefore, by examining the overconfidence in the Taiwan stock market, it can remind Taiwan stock investors to avoid this irrational behavior to reduce unnecessary losses. This is also the main research motivation of this research.

The disposition effect pointed out by Shefrin and Statman [6] is that investors tend to continue to hold stocks that are currently losing money and sell stocks with capital gains due to psychological factors such as self-esteem or fear of regret. The disposition effect is reflected in the stock market trading, which will produce a reaction
similar to the effect of overconfidence. Investors who have the disposition effect will increase their trading volume due to the increase in return of individual stocks. The excessive trading volume in the stock market may not only be affected by investors’ overconfidence, but we cannot rule out the possibility of being affected by the disposition effect. In addition, when overconfidence is tested by transaction volume, if the effect of the sanction is not taken into consideration, the transaction volume caused by the disposition effect will be mistakenly attributed to the research bias caused by overconfidence. Therefore, this research is necessary to separate the overconfidence from the transaction caused by the disposition effect, and to verify the overconfidence and the disposition effect at the same time.

Based on the above discussions, in order to explore the effect of overconfidence and disposition effect, this research first verifies the tendency of overconfidence with the return rate and turnover rate of the overall market. Then, uses market returns, individual stock returns and individual stock turnover rates to simultaneously test the overconfidence and the disposition effect. Hopefully, the empirical results for the overconfidence behavior and disposition effect of investors in this study can provide suggestions for the investment decision in the Taiwan stock market.

The remaining of the study is organized as follows. Section 2 reviews the necessary literature which also provides the theoretical background for the concepts of overconfidence and disposition effects. Section 3 briefly describes the research hypotheses and model setups in this study. Section 4 discusses the empirical results and analysis. Section 5 presents the concluding remarks.

2. Relevant Literature Review

As indicated by many literature, investors often exhibit the two main behavioral biases of overconfidence and disposition effects and may make poor trading decisions in the stock market. There is extensive research on specific biases that influence investor behavior. For the purpose of this study, we only focus on overconfidence and disposition effects. Given that investors often make two mistakes: (i) excessive trading caused by overconfidence, and (ii) stock traders tend to sell winners and hold losers in a trading pattern, when disposing of stocks, which is the so-called disposition effect (Barber and Odean [7]; Chen, Kim, Nofsinger and Rui [8]; Siwar [9]; Ben-David and Hirshleifer [10]; Prosad, Kapoor, Sengupta and Roychoudhary [11]; Bhatia and Sharma [12] and Trejos, van Deemen, Rodriguez and Gomez [13]). In this section, the necessary literature review provides the theoretical background for the concepts of overconfidence and the disposition effect, and attempts to link these two biases. Especially, this section reviews these two concepts and reports on recent research related to them. In particular, this section reviews these two concepts and reports on recent research related to them.

The theory of overconfidence is one of the important theories in behavior finance. In this subject, the study of overconfidence behaviors such as self-attribution bias has gradually received attention in recent years. More and more researches studying this research believe that, compared with the traditional efficient market hypothesis (Fama [14,15]), the trading behavior caused by overconfidence and the phenomenon reflected in the price-volume relationship are closer to the real human behavior. It also better reflects the performance of the real market.

People’s behavior indicates that they are stronger than they actually are, which is called overconfidence in psychology (Chen, Kim, Nofsinger, and Rui [8]). The concept of overconfidence originated from a large number of cognitive psychology experiments and surveys, in which subjects overestimated their predictive ability and the accuracy of the information provided (Yates [16]; Campbell, Goodie and Foster [17]; Zaiane and Abaoub [18]; Ouarda and El Bori [19] and Mushinada and Veluri [20]). People do not calibrate well in estimating the probability of events they think will happen. In short, people think they have better information than they actually are. Overconfidence does not necessarily mean people are ignorant or incompetent. Rather, people think that their judgments and estimates of the situation are better than the actual situation (Pompian [21]). Some studies have shown that investors tend to be overconfident in their financial decisions (Fischhoff, Slovic and Lichtenstein [22]; Statman, Thorley and Vorkink, [2]; Chuang and Lee [3]; Zaiane and Abaoub [18]; Ouarda and El Bori [19] and Mushinada and Veluri [20]).

Since the increase in investment market volatility in recent years is often accompanied by violent fluctuations in trading volume, it can also be guessed that investors in the market are often stimulated by the previous rewards and losses, resulting in more active or inactive transactions in the next period. Once the stock price rises violently, investors’ behaviors such as overconfidence, over-optimism, and self-attrition bias will appear at any time. Therefore, it is understood that part of the fluctuations in the trading volume in the market may be associated with the phenomenon caused by investors’ overconfidence. The research of Barber and Odean [7,23,24] used detailed stock trading data of individual investors as samples, and empirically found that retail investors have a clear tendency to overconfidence. Because these investors in the sample will adopt a positive attitude to trade stocks, and actively trading stocks did not bring higher return on investment for these investors. In addition, from the perspective of the entire market, Statman, Thorley, Vorkink [2], Chuang and Lee [3], Ho [4] and Liu, Chuang, Huang and Chen [5] also found that most investors have overconfidence, so overconfidence is the majority of investment People's unavoidable systematic cognitive bias. Overconfident traders believe that the private information they possess is more correct than the information revealed. Stock market trading volume and stock market volatility will increase due to the degree of investor overconfidence. Investors will trade more frequently, but their performance is worse than before. When investors’ confidence increases, investors will trade riskier stocks. They believe this is due to the overconfidence of these investors.

In addition, Shefrin and Statman [6] mentioned the disposition effect. They pointed out that sometimes investors will choose to continue to hold the loss-making
portfolio due to psychological factors such as self-esteem or fear of regret and sell the profitable part. In stock trading, the disposition effect often produces situations similar to the effect of overconfidence (Kadous, Tayler, Thayer and Young [25]). Excessive trading volume in the stock market may be affected by overconfidence. Investors with disposition effect may also increase trading volume due to the profit and loss of their investment portfolio. We cannot be sure that the abnormal fluctuations in trading volume are entirely due to overconfidence. Therefore, when testing overconfidence by trading volume, if the disposition effect is not taken into consideration, it may mistakenly attribute the fluctuation of the amount caused by the disposition effect to the bias caused by overconfidence.

Odean [1] and Frazzini [26] found that traders usually hold the losers too long and sell the winners too early. Grinblatt and Keloharju [27] also presented the Finnish investors wouldn’t like to realize the losses. Cerqueira Leal, Armada and Duque [28] found the strong evidence of the disposition effect on the Portuguese stock market, and the disposition effect is stronger in bull market than in bear market. Barber and Odean [29] and Kadous, Tayler, Thayer and Young [25] found that lower self-regard (and/or higher confidence) investors will hold losing investments longer than higher self-regard (and/or lower confidence). Heimer [30] examined the relationships between the social interaction and disposition effect, and find that individuals will have doubles disposition effect if they contact the social interactions. Komai, Koyano and Miyakawa [31] estimated the investors’ trading activities accounting for buying and selling stocks conditional on the observed returns of Japanese stocks. The results indicate that the individual investors make contrarian trades, i.e., tend to buy stocks exhibiting lower past return. In order to understand the disposition effect of bonds, which are as strong as stocks, Hincapie-Salazar and Agudelo [32] applied Odean's [33] measurements to proprietary trading databases with unique investor IDs from emerging market exchanges that trade both stocks and bonds. They found that bonds have a certain disposition effect, but they are much lower than stocks, and a positive relation between the two measures by investor. In addition, they also show that local individuals and family offices in these two markets have significant disposition effects. In contrast, long-term institutions, brokerage companies and foreign investors do not show this biased trends.

The theory of overconfidence and the disposition effect can be seen at the earliest by the prospect theory proposed by Kahneman and Tversky [34]. This argument explains why independent individuals prefer risk in some situations, but they do not at other times. Retention of risk is a contradiction that traditional expected utility theory cannot explain. In addition, the theory also points out that people have cognitive biases, which are not completely rational as described in traditional theories. That is, when people face decisions, they often use past experience or intuition to make judgments (De Bondt and Thaler [35]). Take the overconfidence of investors as an example. Usually when the stock price soars after the investor buys a stock, the investor will think that his judgment is correct and he has thought about it, so he buys a profitable stock. However, in hindsight, the investment positions that investors often buy are relatively risky, which often results in the dilemma that the initial profits are not enough to make up for the current losses (Trejos, van Deemen and Gomez [13]). The proposal of the prospect theory has indeed produced a considerable degree of incentive effect for researches who want to find the best explanation for the abnormal phenomenon, and then gradually changed from the perspective of investor irrational for further discussion, hoping to find out what people will deal with. Decision-making is more truly reflected in the behavioral pattern of market investment amount or transaction volume. Among them, Shefrin [36] mainly divides the subject of this school into three categories, each of which is heuristic-driven bias, frame dependence and inefficient markets. The overconfidence discussed in this belongs to the category of heuristic-driven bias. Recently, Khan, Afeef, Adil and Ullah [37] attempted to detect the behavioral factors affecting the investment decisions of institutional investors in the asset management industry of Pakistan through partial least squares structural equation model (PLS-SEM). The empirical results show that institutional investors are significantly tend to behavioral biases, such as disposition effects, overconfidence biases, psychological accounting, and diversification biases. These findings signify that institutional investors in Pakistan are not entirely rational economic agents. Instead, behavioral and personality factors correlate with their investment decisions, making them bounded rational.

3. Research Hypotheses and Model Setups

The research hypotheses and model setups corresponding to the hypotheses in this study are discussed in this section.

3.1. Research hypotheses

Based on above related theory and literature review, this study set up two hypotheses that mainly consider the concept of Chuang and Lee [3] on investor overconfidence, using Odean [1,33] and Gervais and Odean [38] to verify overconfidence by testing inter-temporal changes in transaction volume, and also incorporate the disposition effects pointed out by Statman, Thorley, and Vorkink [2] to construct a complete model to conduct an empirical analysis of the overconfidence and disposition effect of investors in the Taiwan stock market. The two main hypothesis of this research is described as follows:

Hypothesis 1(H1): Investors still have overconfidence after verifying the influence of overconfidence and disposition effects on trading volumes at the same time.

Hypothesis 2(H2): Overconfidence investors tend to underestimate the risks and hold the riskier stocks due to their too much faith in their stock selection ability and trade too many high-risk stocks.

In accordance with the four hypotheses mentioned above, this study uses the tri-variate VAR-GARCH model to examine the overconfidence behavior and deposition
3.2. Model Setups

The models corresponding to the above hypotheses in this study are constructed as follows:

To test the hypothesis H1, this study uses a tri-variate vector autoregressive (VAR) with GARCH (tri-variate VAR-GARCH) model.

1. Conditional Mean Equation

\[
\begin{align*}
\text{turn}_t &= A_1 + \sum_{k=1}^{3} B_{1k} \text{turn}_{t-k} + \sum_{k=1}^{3} C_{1k} \text{ret}_{t-k} \\
&+ \sum_{k=1}^{3} \epsilon_{1k} \text{mret}_{t-k} + \sum_{k=0}^{3} F_{1k} \text{pvol}_{t-k} + \epsilon_{\text{turn}_t} \\
\text{ret}_t &= A_2 + \sum_{k=1}^{3} B_{2k} \text{turn}_{t-k} + \sum_{k=1}^{3} C_{2k} \text{ret}_{t-k} \\
&+ \sum_{k=1}^{3} \epsilon_{2k} \text{mret}_{t-k} + \sum_{k=0}^{3} F_{2k} \text{pvol}_{t-k} + \epsilon_{\text{ret}_t} \\
\text{mret}_t &= A_3 + \sum_{k=1}^{3} B_{3k} \text{turn}_{t-k} + \sum_{k=1}^{3} C_{3k} \text{ret}_{t-k} \\
&+ \sum_{k=1}^{3} \epsilon_{3k} \text{mret}_{t-k} + \sum_{k=0}^{3} F_{3k} \text{pvol}_{t-k} + \epsilon_{\text{mret}_t}
\end{align*}
\]

2. Conditional Variance Equation

\[
\begin{align*}
\text{h}_{\text{turn},t} &= \epsilon_{12} + \epsilon_{23} \text{h}_{\text{turn},t-1} + \epsilon_{31} \text{h}_{\text{ret},t-1} + \epsilon_{4t} \\
\text{h}_{\text{ret},t} &= \epsilon_{21} + \epsilon_{32} \text{h}_{\text{ret},t-1} + \epsilon_{4t} \\
\text{h}_{\text{mret},t} &= \epsilon_{31} + \epsilon_{42} \text{h}_{\text{mret},t-1} + \epsilon_{4t}
\end{align*}
\]

3. Conditional Co-variance Equation

\[
\begin{align*}
\text{h}_{\text{turn} \cdot \text{ret},t} &= \epsilon_{13} + \epsilon_{24} \text{h}_{\text{turn} \cdot \text{ret},t-1} \\
\text{h}_{\text{turn} \cdot \text{mret},t} &= \epsilon_{14} + \epsilon_{23} \text{h}_{\text{turn} \cdot \text{mret},t-1} \\
\text{h}_{\text{ret} \cdot \text{mret},t} &= \epsilon_{24} + \epsilon_{31} \text{h}_{\text{ret} \cdot \text{mret},t-1} \\
\epsilon_t &= \left[ \begin{array}{c} \epsilon_{\text{turn},t} \\ \epsilon_{\text{ret},t} \\ \epsilon_{\text{mret},t} \end{array} \right], \epsilon_t \sim N(0, H_t) \\
H_t &= \begin{bmatrix} \text{h}_{\text{turn},t} & \text{h}_{\text{turn} \cdot \text{ret},t} & \text{h}_{\text{turn} \cdot \text{mret},t} \\ \text{h}_{\text{turn} \cdot \text{ret},t} & \text{h}_{\text{ret},t} & \text{h}_{\text{ret} \cdot \text{mret},t} \\ \text{h}_{\text{turn} \cdot \text{mret},t} & \text{h}_{\text{ret} \cdot \text{mret},t} & \text{h}_{\text{mret},t} \end{bmatrix}
\]

Where

- turn<sub>t</sub>: Individual stock turnover at time t
- ret<sub>t</sub>: Individual stock return at time t
- mret<sub>t</sub>: Market return at time t
- pvol<sub>t</sub>: Stock return volatility at time t
- ε<sub>turn</sub><sub>t</sub>, ε<sub>ret</sub><sub>t</sub>, ε<sub>mret</sub><sub>t</sub>: Residual terms of conditional mean equations at time t.
- A<sub>1k</sub>, A<sub>2k</sub>, A<sub>3k</sub>: Intercept terms of conditional mean equations
- B<sub>1k</sub>, B<sub>2k</sub>, B<sub>3k</sub>: Coefficients of delayed individual stock turnover
- C<sub>1k</sub>, C<sub>2k</sub>, C<sub>3k</sub>: Coefficient of delayed individual stock return returns
- F<sub>1k</sub>, F<sub>2k</sub>, F<sub>3k</sub>: Coefficient of pvol<sub>t</sub>
- h<sub>\text{turn},1</sub>: Conditional variance of turn<sub>t</sub>
- h<sub>\text{ret},1</sub>: Conditional variance of ret<sub>t</sub>
- h<sub>\text{mret},1</sub>: Conditional co-variance of turn<sub>t</sub> and ret<sub>t</sub>
- h<sub>\text{turn} \cdot \text{ret},1</sub>: Conditional co-variance of turn<sub>t</sub> and mret<sub>t</sub>
- h<sub>\text{ret} \cdot \text{mret},1</sub>: Conditional co-variance of ret<sub>t</sub> and mret<sub>t</sub>
- v<sub>11</sub>, v<sub>12</sub>, v<sub>13</sub>: GARCH effects of turn<sub>t</sub>, ret<sub>t</sub> and mret<sub>t</sub> in conditional variance equations
- v<sub>12</sub>, v<sub>21</sub>, v<sub>23</sub>: ARCH effects of turn<sub>t</sub>, ret<sub>t</sub> and mret<sub>t</sub> in conditional variance equations
- v<sub>12</sub>, v<sub>13</sub>, v<sub>23</sub>: Intercept terms of conditional co-variance equations
- v<sub>12</sub>, v<sub>13</sub>, v<sub>23</sub>: Measure the effects of cross volatility (h<sub>\text{turn},1</sub>, h<sub>\text{turn} \cdot \text{ret},1</sub>, h<sub>\text{ret} \cdot \text{mret},1</sub>) on co-variance of each two variables about turn<sub>t</sub>, ret<sub>t</sub>, and mret<sub>t</sub>

The above VAR-GARCH type model established by this study can overcome the doubts about the identification of endogenous and exogenous variables, and can show the influence of any variable on all other variables. Therefore, this study uses the tri-variate VAR-GARCH model, which treats both individual stock return rates (ret<sub>t</sub>), turnover (turn<sub>t</sub>) and market return rates (mret<sub>t</sub>) as endogenous variables, and stock price fluctuations (pvol<sub>t</sub>) is also considered since the model will be applied to each stock individually, it does not need to be spread over stock returns. The reason for taking pvol<sub>t</sub> as an exogenous variable is based on Karpoff’s [39] research and used to examine the contemporaneous relationship between individual stock trading volume (turnover), individual stock return, market return and its volatility in this study. Ross [40] indicated that in a market that lacks friction (no arbitrage opportunities), the proportion of information flow can be observed by the degree of price fluctuations. Therefore, this study uses pvol<sub>t</sub> variable to take into account price fluctuations of transactions caused by information from other firms or market. This exogenous variable that controls fluctuations is similar to the mean absolute deviation (MAD) used by Bessembinder, Chan and Seguin [41] and follow the setting of French, Schwert and Stambaugh [42] to represent the firm-specific information flow that affects market transactions. The calculation method of week pvol<sub>t</sub> used in this study is as follows:
\[ pvol_t = \sum_{t=1}^{T} \left( \sum_{k=1}^{K} c_{1k} \right)'^2 + 2 \sum_{t=1}^{T} r_{t} r_{t-1} \]  

(10)

Where \( r_t \) is the stock return on day \( t \), and \( T \) is the number of trading days in the week.

As for the selection of the most suitable lag term of the VAR model, after detecting from the ADF unit-root test that according to the AIC criterion, this study selects lag 3 periods as the optimal number of lag periods. We also find that there is a heterogeneous variance in the estimated errors of these three equations by ARCH-LM test. Then, tri-variate VAR-GARCH is used to estimate and discusses the interactive relationship among individual stock return (\( ret_t \)), individual stock turnover (\( turn_t \)) and market return (\( mret_t \)) to examine and identify the overconfidence behavior and disposition effect of investors in the Taiwan stock market.

According to the results of model estimation, if we find \( \sum_{k=1}^{K} c_{1k} \) significantly positive, it means that investors will receive an increase in the return of individual stocks and tend to sell individual stocks, which means that investors have the disposition effect. If \( \sum_{k=1}^{K} c_{1k} \) is significantly positive, it means that investors will be motivated by market profits and their investment confidence will increase, and they will trade more actively in the following period, that is, investors have overconfidence. If \( \sum_{k=1}^{K} c_{1k} \) and \( \sum_{k=1}^{K} c_{2k} \) are both positive and significant, it means that in this stock, we observe that investors have both disposition effect and overconfidence behavior.

For testing Hypothesis \( H_2 \), we regard the size of the company as the degree of risk of the company, that is, the risk of large companies is smaller, and the risk of small companies is greater. The size of the company is measured by the average market value during the sample period. After averaging the daily market value of all companies during the sample period, rank the companies with the top 50 market capitalization as a low-risk portfolio, and the smallest market capitalization 50 Companies are considered as high-risk investment portfolios. Under the above model for verification and based on the theory of overconfidence, this study expects that in companies with small market capitalization, the overconfidence will be stronger than companies with large market capitalization.

4. Empirical Results and Analysis

4.1. Data Sources, Data Processing, Unit-Root Test and ARCH-LM Test for VAR Model Residuals

Before conducting empirical analysis, it is necessary to describe all the research data and determine the appropriate measurement model based on the type of data. In order to facilitate the subsequent research steps and obtain more accurate empirical results. This section first introduces the source and selection of research data, the data processing, and then explains the results of unit-root test as well as ARCH-LM test for VAR model residuals.

(1) Data Sources and Processing

The aim of this research is to explore whether there is overconfidence behavior and disposition effect in the Taiwan stock market. The Taiwan stock market index and the stock price data of listed companies are used as the research objects. In terms of Taiwan stock market index, this study extracts the daily data of the Taiwan Economic Journal (TEJ) from January 8, 1998 (Thursday) to December 26, 2007 (Wednesday), this period is chosen to avoid the abnormal influences of rare occurrences of less special events, and to clearly examine overconfidence and disposition effect. About ten years of ex-dividend adjustment, the daily data of the market index constructs the market weekly return and turnover rate required by this research. In addition to avoiding the situation that certain stocks have zero daily trading volume, the weekly data used in this study mainly considers the speed of overconfidence reactions. After the investor obtains the profit, there is usually a slight delay before the next transaction. This study uses the weekly data to carry out empirical analysis.

In addition, with the development of the Taiwan stock market, the number of listed companies has continued to increase, and the total number of listed shares has also increased. If the transaction volume is simply used to measure the amount of transactions, it will inevitably be affected by the increase in the number of shares, and the data will lose its accuracy. Therefore, this research uses turnover rate to represent the amount of transactions to avoid this situation. In terms of stock price information of listed companies, the selected data period is the same as that of the market index. This research first selects 321 listed companies that have been listed for trading since January 8, 1998 and are still in the centralized market as of December 26, 2007. Then, in order to ensure the consistency of the sample length, if the 321 stocks have stopped trading during the sample period (for example, UMC (company code 2303)) reduced its capital on September 20, 2007 and ceased its listing until October 9, 2007. Weekly observations that do not match the market (506 observations in total) will also be eliminated. After this procedure, a total of 263 stocks are eligible. This study uses the data of 263 stocks as the stock price of the listed company data. In order to avoid the implied weekly effect of the turnover rate and the rate of return from causing errors in the estimation results, the turnover rate and the weekly rate of return in this study are both calculated starting from Thursday and accumulating to the next Wednesday. Returns of stock at time \( t \), \( R_t \), is defined as: \( R_t = \log(P_t/P_{t-1}) \) and \( P_t \) denotes the weekly stock price at time \( t \).

(2) Results of Unit-Root Test and ARCH-LM Test for VAR Model Residuals

The augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used to test for unit roots. The results
reported in Table 1 shows that both the ADF and the PP models are greater than their respective critical values of individual stock return (rett), individual stock turnover (turnt) and market return (mrett). This suggests that the unit root hypothesis is rejected for individual stock return (rett), individual stock turnover (turnt) and market return (mrett). None of the data series for the three variables exhibit the unit root. It shows that there are stationary series.

Table 1. ADF Unit Root Test for Individual Stock Turnover (turnt), Individual Stock Return (rett) and Market Return (mrett)

| ADF unit-root test | Intercept but without trend | Intercept and trend | Without intercept and trend |
|--------------------|-----------------------------|---------------------|----------------------------|
| turn               | -21.6180*** [0]             | -21.6317*** [0]     | -21.6394*** [0]           |
| ret                | -6.0155*** [1]              | -6.2103*** [1]      | -2.1902*** [1]            |
| mrett              | -33.2102***[1]              | -33.0403***[1]      | -33.2345***[1]            |

| PP unit-root test | Return series |
|-------------------|---------------|
| turn              | -21.6180*** [0] |
| ret               | -6.0155*** [1]  |
| mrett             | -33.2102***[1] |

Note: 1. [.] indicates lag periods based on Akaike Information Criterion (AIC) 2. ***denotes the significance at the 1% level.

Based on the results of the ADF and PP unit-root tests, it can be determined that the individual stock turnover (turnt), individual stock return (rett) and market return (mrett) used in this study are all stationary series. Therefore, the vector autoregressive (VAR) model (Equations (1), (2) and (3)) can be used instead of the vector error correction model (VECM). We also find that there is a heterogeneous variance in the estimated errors of these three conditional mean equations by ARCH-LM test (Table 2). Then, tri-variate VAR-GARCH (Equations (1), (2)… and (9)) is used to estimate and discuss the interactive relationship among individual stock return (rett), individual stock turnover (turnt) and market return (mrett) to examine and identify the overconfidence behavior and deposition effect of investors in the Taiwan stock market.

Table 2. ARCH-LM Tests for VAR Model Residuals (\( \varepsilon_t^2 \)) in Conditional Mean Equations (1), (2) and (3)

| Conditional Mean Equation | Lagged periods of \( \varepsilon_t^2 \) | Individual stock turnover (turn) | Individual stock return (rett) | Market return (mrett) |
|---------------------------|--------------------------------------|---------------------------------|------------------------------|----------------------|
| LM(4)                     | 20.3246***                           | 16.2312***                      | 22.2324***                   |
| LM(8)                     | 15.1223***                           | 12.9884***                      | 16.2890***                   |
| LM(12)                    | 14.5415***                           | 10.2567***                      | 14.3543***                   |
| LM(16)                    | 13.2326***                           | 7.9765***                       | 12.4416***                   |
| LM(20)                    | 11.8567***                           | 7.3554***                       | 10.9684***                   |

Note: 1. LM (4), LM (8)… and LM (20) are ARCH-Lagrange multiplier tests using \( \chi^2 \) (4), \( \chi^2 \) (8)… and \( \chi^2 \) (20) statistics for squared residuals when regressing themselves on 4, 8… and 20 own lags. 2. ***denotes the significance at the 1% level.

4.2. Results and Analysis of Empirical Testing for Research Hypotheses

Based on the empirical results of tri-variate VAR-GARCH model, we can verify the research hypotheses in this study.

(1) Verification of Overconfidence Behavior and Disposition Effect

Hypothesis 1(H1): Investors still have overconfidence after verifying the influence of overconfidence and disposition effects on trading volumes at the same time.

The tri-variate VAR-GARCH (Equations (1), (2)… and (9)) constructed in this study can simultaneously estimate the impact of the disposition effect and the overconfidence effect on the turnover rate. The coefficients of tri-variate VAR-GARCH model is estimated by quasi-maximum likelihood estimation (QMLE), the maximum likelihood estimates of the parameters are obtained by numerical maximization of the log-likelihood function using the Marquardt [43] algorithm, which is an updated modification of the well-known BHHH method of Berndt, Hall, Hall, Hausman [44]. Based on the estimated results, when the turnover of individual stocks is significantly positively affected by the return of individual stocks in the previous period (\( \sum_{k=1}^{K} c_{1k} \), k=1, 2 and 3), which means that individual stock investors have a disposition effect. When the turnover of individual stocks is significantly positively affected by the previous market return (\( \sum_{k=1}^{K} c_{k} \), k=1, 2 and 3), it means that individual stock investors have an overconfidence effect. On these basis, this study verifies the selected individual stocks whether investors have disposition effects and overconfidence effects.

It should be noted that due to the large number of individual stocks selected, the estimation results of the individual stocks are not listed one by one, but the estimation results and the disposition effect and the overconfidence effect are really verified. This research divides the empirical results into four categories, namely (1) Stocks with overconfidence effects only. (2) Stocks with disposition effects only. (3) Stocks with overconfidence effects and disposition effects. (4) Stocks with overconfidence effect are really verified. This research divides the empirical results into four categories, namely (1) Stocks with overconfidence effects only. (2) Stocks with disposition effects only. (3) Stocks with overconfidence effects and disposition effects at the same time. (4) Neither overconfidence effect nor disposition effects. Here, only one stock (represented by company code) is selected to show the results for each category and indicated in Tables 3, 4, 5 and 6 for proving each results. In order to check the adequacy of the model, in this study we used the Ljung-Box Q test to calculate the standardized residuals and squared residuals and cross-product of standardized residuals. As indicated in Table 3, Table 4, Table 5 and Table 6, all results of Ljung-Box Q tests (Q(12), Q(18) and Q(24)) fail to reject the null hypothesis that the estimated standardized residuals (\( Z_{\varepsilon_{turn},t} \), \( Z_{\varepsilon_{rett},t} \) and \( Z_{\varepsilon_{mrett},t} \)) and squared standardized residuals (\( Z_{\varepsilon_{turn},t}^2 \), \( Z_{\varepsilon_{rett},t}^2 \) and \( Z_{\varepsilon_{mrett},t}^2 \)) and cross-product of the two standardized residuals (\( Z_{\varepsilon_{turn},t} \times Z_{\varepsilon_{rett},t} \) and \( Z_{\varepsilon_{turn},t} \times Z_{\varepsilon_{mrett},t} \) and \( Z_{\varepsilon_{rett},t} \times Z_{\varepsilon_{mrett},t} \)).
Conditional Mean Equation

| Individual stock turnover ($turn_t$) | Individual stock return ($ret_t$) | Market return ($mret_t$) |
|-------------------------------------|----------------------------------|-------------------------|
| $A_1$ 0.0020 * | 1.8272 | $A_2$ -0.0003 | -0.0949 | $A_3$ 0.0016 | 0.6412 |
| $B_{11}$ 0.3974 * * * | 8.4859 | $B_{21}$ 0.0056 | 0.0427 | $B_{31}$ -0.1454 | -1.3396 |
| $B_{12}$ 0.1305 * * * | 2.6140 | $B_{22}$ -0.0156 | -0.1126 | $B_{32}$ 0.1760 | 1.5210 |
| $B_{13}$ 0.2194 * * * | 4.8925 | $B_{23}$ 0.0975 | 0.7819 | $B_{33}$ -0.8036 | 0.4220 |
| $C_{11}$ -0.0161 | -0.8308 | $C_{21}$ -0.0608 | -1.1304 | $C_{31}$ 0.0644 | 1.4380 |
| $C_{12}$ -0.0102 | -0.5274 | $C_{22}$ -0.0856 | -1.5908 | $C_{32}$ -0.0615 | -1.3708 |
| $C_{13}$ -0.0132 | -0.6970 | $C_{23}$ 0.0334 | 0.6353 | $C_{33}$ 0.0106 | 0.2412 |
| $c_{11}$ 0.1054 * * * | 4.7813 | $c_{21}$ 0.0463 | 0.7556 | $c_{31}$ 0.0109 | 0.2129 |
| $c_{12}$ 0.0696 * * * | 3.0782 | $c_{22}$ 0.1542 * * * | 2.4534 | $c_{32}$ 0.1086 * * * | 2.0736 |
| $c_{13}$ 0.0365 | 1.6091 | $c_{23}$ -0.0422 | -0.6685 | $c_{33}$ -0.0616 | -1.1710 |
| $F_{10}$ 1.9344 * * * | 9.3301 | $F_{20}$ -0.0758 | -0.1314 | $F_{30}$ -0.3923 | -0.8163 |
| $F_{11}$ 0.1899 | 0.8376 | $F_{21}$ -0.0665 | -0.1054 | $F_{31}$ 1.1382 * * * | 2.1658 |
| $F_{12}$ -0.3517 | -1.5514 | $F_{22}$ -0.9687 | -1.5359 | $F_{32}$ -0.2870 | -0.5461 |
| $F_{13}$ 0.1033 | 0.4704 | $F_{23}$ 0.3251 | 0.5322 | $F_{33}$ -0.7066 | -1.3880 |

Conditional Variance Equation

$\varepsilon_t = \varepsilon_t \varepsilon_{t-1} \varepsilon_t \varepsilon_{t-1}$ have no autocorrelation and ARCH effects. Therefore, these above tests verify that the VAR-GARCH model we estimated is an appropriate specification for the relationships among individual stock turnover ($turn_t$), individual stock return ($ret_t$) and market return ($mret_t$) and the empirical results are also useful and applicable.

Table 3. Estimation Results for Individual Stocks with Overconfidence Effects Only (Company Code 1451)

| Conditional Varniance Equation | Conditional Co-variance Equation | Goodness-of-Fit Test and Diagnostic Checking |
|--------------------------------|----------------------------------|---------------------------------------------|
| $h_{\text{turn},t}$ | $h_{\text{ret},t}$ | $h_{\text{mret},t}$ |
| $\nu_{c_1}$ 2.96577E-06 * | 1.8892 | $\nu_{a_1}$ 1.9982 E-05 * | 1.8989 | $\nu_{b_1}$ 0.000081 * * | 2.1974 |
| $\nu_{c_2}$ 0.9498 * * * | 26.0012 | $\nu_{a_2}$ 0.8912 * * * | 15.2791 | $\nu_{b_2}$ 0.7947 * * * | 12.5320 |
| $\nu_{c_3}$ 0.0482 * * * | 2.3672 | $\nu_{a_3}$ 0.0501 * * | 2.4571 | $\nu_{b_3}$ 0.1358 * * * | 3.2832 |

$Z_{\text{turn}} = \varepsilon_{\text{turn}} \sqrt{h_{\text{turn}}}$

$Z_{\text{ret}} = \varepsilon_{\text{ret}} \sqrt{h_{\text{ret}}}$

$Z_{\text{mret}} = \varepsilon_{\text{mret}} \sqrt{h_{\text{mret}}}$

| $Z_{\text{turn}}$ | $Z_{\text{ret}}$ | $Z_{\text{mret}}$ |
|------------------|------------------|------------------|
| Q(12) 7.321 | 7.879 | 6.889 |
| Q(18) 13.672 | 14.512 | 11.668 |
| Q(24) 19.542 | 19.456 | 17.345 |

$Z_{\text{turn}} = Z_{\text{turn}}^2$

$Z_{\text{ret}} = Z_{\text{ret}}^2$

$Z_{\text{mret}} = Z_{\text{mret}}^2$

| $Z_{\text{turn}} \cdot Z_{\text{ret}}$ | $Z_{\text{turn}} \cdot Z_{\text{mret}}$ | $Z_{\text{ret}} \cdot Z_{\text{mret}}$ |
|-----------------|-----------------|-----------------|
| Q(12) 7.531 | 7.471 | 7.321 |
| Q(18) 11.627 | 12.226 | 12.589 |
| Q(24) 15.758 | 14.615 | 16.548 |
Table 4. Estimation Results for Individual Stocks with Disposition Effects Only (Company Code 2511)

### Conditional Mean Equation

| Individual stock turnover (\(\text{turn}_t\)) | Individual stock return (\(\text{rel}_t\)) | Market return (\(\text{mret}_t\)) |
|---------------------------------------------|-------------------------------------------|-------------------------------|
| \(A_1\) 0.0029** | 4.0683 | \(A_2\) 0.0047 | 1.0033 | \(A_3\) 0.0058** | 2.2143 |
| \(B_{11}\) 0.3384** | 6.7963 | \(B_{21}\) -0.7720** | -2.3880 | \(B_{31}\) -0.0128 | -0.0704 |
| \(B_{12}\) 0.1668** | 3.1212 | \(B_{22}\) 0.4083 | 1.1764 | \(B_{32}\) -0.0547 | -0.2798 |
| \(B_{13}\) 0.2086** | 4.4256 | \(B_{23}\) -0.0824 | -0.2693 | \(B_{33}\) -0.0298 | -0.1727 |
| \(C_{11}\) 0.0412** | 4.3881 | \(C_{21}\) -0.0321 | -0.5262 | \(C_{31}\) -0.0617* | -1.7952 |
| \(C_{12}\) 0.0271** | 2.8124 | \(C_{22}\) 0.1008 | 1.6091 | \(C_{32}\) 0.0316 | 0.8955 |
| \(C_{13}\) 0.0042 | 0.4744 | \(C_{23}\) 0.0983* | 1.7232 | \(C_{33}\) 0.0498 | 1.5507 |
| \(c_{11}\) 0.0229 | 1.5172 | \(c_{21}\) 0.3055** | 3.1112 | \(c_{31}\) 0.0836 | 1.5125 |
| \(c_{12}\) 0.0098 | 0.6415 | \(c_{22}\) 0.0462 | 0.4654 | \(c_{32}\) 0.0407 | 0.7275 |
| \(c_{13}\) -0.0114 | -0.7520 | \(c_{23}\) -0.1391 | -1.4096 | \(c_{33}\) -0.0889 | -1.5987 |
| \(F_{10}\) 0.4615** | 7.2728 | \(F_{20}\) 0.8505** | 2.0643 | \(F_{30}\) -0.8413** | -3.6258 |
| \(F_{11}\) 0.0242 | 0.3545 | \(F_{21}\) 0.2771 | 0.6243 | \(F_{31}\) 0.1979 | 0.7918 |
| \(F_{12}\) -0.1224* | -1.7990 | \(F_{22}\) -0.4702 | -1.0640 | \(F_{32}\) 0.0265 | 0.1064 |
| \(F_{13}\) -0.1121* | -1.6808 | \(F_{23}\) -0.1921 | -0.4436 | \(F_{33}\) -0.3693 | -1.5143 |

### Conditional Variance Equation

| \(h^2_{\text{turn}_t}\) | \(h^2_{\text{rel}_t}\) | \(h^2_{\text{mret}_t}\) |
|------------------------|------------------------|------------------------|
| \(v_{c1}\) 3.1123E-06* | 1.9201 \(v_{a1}\) 2.1130E-05* | 1.9113 \(v_{b1}\) 0.000066* | 2.6721 |
| \(v_{c2}\) 0.9568** | 25.9921 \(v_{a2}\) 0.9461** | 14.0011 \(v_{b2}\) 0.8417** | 10.8324 |
| \(v_{c3}\) 0.0401** | 2.2151 \(v_{a3}\) 0.0415** | 2.3122 \(v_{b3}\) 0.1432** | 4.5645 |

### Conditional Co-variance Equation

| \(h_{\text{turn}\_ret}\) | \(h_{\text{turn}\_mret}\) | \(h_{\text{ret}\_mret}\) |
|------------------------|------------------------|------------------------|
| \(v_{c1,2}\) -0.0062** | -3.2410 \(v_{a1,2}\) 0.0028** | 3.6295 \(v_{b1,2}\) 0.0125** | 7.5235 |
| \(v_{c1,3}\) 0.6562** | 9.0873 \(v_{a1,3}\) 0.0297* | 1.7613 \(v_{b1,3}\) 0.0135* | 1.7065 |
| \(v_{c2,3}\) 0.0170** | 2.5921 \(v_{a2,3}\) 0.0489** | 3.8314 \(v_{b2,3}\) 0.0141* | 2.2159 |

### Goodness-of-Fit Test and Diagnostic Checking

\[
Z_{\text{turn}_t} = \frac{\varepsilon_{\text{turn}_t}}{\sqrt{h^2_{\text{turn}_t}}} \\
Z_{\text{rel}_t} = \frac{\varepsilon_{\text{rel}_t}}{\sqrt{h^2_{\text{rel}_t}}} \\
Z_{\text{mret}_t} = \frac{\varepsilon_{\text{mret}_t}}{\sqrt{h^2_{\text{mret}_t}}}
\]
### Table 5. Estimation Results for Individual Stocks with Overconfidence and Disposition Effects (Company Code: 1459)

|                  | Individual stock turnover (\(\text{turn}_i\)) | Individual stock return (\(\text{ret}_i\)) | Market return (\(\text{mret}_i\)) |
|------------------|-----------------------------------------------|---------------------------------------------|----------------------------------|
| \(A_1\)         | 0.0043 * *                                   | 2.4444                                      | \(A_2\) 0.0047                  |
| \(B_{11}\)      | 0.5657 * * *                                 | 11.3043                                     | \(B_{21}\) 0.0548               |
| \(B_{12}\)      | 0.0281                                        | 0.4916                                      | \(B_{22}\) -0.3155 * *         |
| \(B_{13}\)      | 0.1566 * * *                                 | 3.2490                                      | \(B_{23}\) -0.0111              |
| \(C_{11}\)      | 0.0617 * * *                                 | 3.0234                                      | \(C_{21}\) -0.0394              |
| \(C_{12}\)      | 0.0195                                        | 0.9637                                      | \(C_{22}\) 0.0737               |
| \(C_{13}\)      | 0.0075                                        | 0.3937                                      | \(C_{23}\) 0.0684               |
| \(c_{11}\)      | 0.0783 * *                                   | 2.4011                                      | \(c_{21}\) 0.2049 * *          |
| \(c_{12}\)      | 0.0950 * * *                                 | 2.9028                                      | \(c_{22}\) 0.0666               |
| \(c_{13}\)      | 0.0036                                        | 0.1103                                      | \(c_{23}\) 0.0377               |
| \(F_{10}\)      | 1.2373 * * *                                 | 7.4859                                      | \(F_{20}\) -0.5953             |
| \(F_{11}\)      | 0.0021                                        | 0.0117                                      | \(F_{21}\) 1.8492 * * *        |
| \(F_{12}\)      | -0.0438                                       | -0.2407                                     | \(F_{22}\) -0.3385             |
| \(F_{13}\)      | -0.3905 * *                                  | -2.2466                                     | \(F_{23}\) -0.0695             |

### Conditional Variance Equation

\[
\begin{align*}
\hat{\sigma}_{\text{turn},t}^2 & = 2.9277E-06 * 1.8562 \\
\hat{\sigma}_{\text{ret},t}^2 & = 2.2318 E-05 * 1.9823 \\
\hat{\sigma}_{\text{mret},t}^2 & = 0.000054 * * 2.8002 \\
\end{align*}
\]

### Conditional Co-variance Equation

\[
\begin{align*}
\hat{\sigma}_{\text{turn},t} \times \hat{\sigma}_{\text{ret},t} & = -0.0058 * * * -3.8120 \\
\hat{\sigma}_{\text{turn},t} \times \hat{\sigma}_{\text{mret},t} & = 0.0032 * * * 3.7025 \\
\hat{\sigma}_{\text{ret},t} \times \hat{\sigma}_{\text{mret},t} & = 0.0114 * * * 7.6241 \\
\end{align*}
\]

### Goodness-of-Fit Test and Diagnostic Checking

\[
\begin{align*}
\hat{Z}_{\text{turn},t} & = \epsilon_{\text{turn},t}/\sqrt{\hat{\sigma}_{\text{turn},t}^2} \\
\hat{Z}_{\text{ret},t} & = \epsilon_{\text{ret},t}/\sqrt{\hat{\sigma}_{\text{ret},t}^2} \\
\hat{Z}_{\text{mret},t} & = \epsilon_{\text{mret},t}/\sqrt{\hat{\sigma}_{\text{mret},t}^2} \\
\end{align*}
\]

| \(Q(12)\)       | 7.559                                        | 8.831                                        | 7.785                                        |
| \(Q(18)\)       | 13.734                                       | 13.514                                       | 12.342                                       |
| \(Q(24)\)       | 19.567                                       | 20.417                                       | 18.169                                       |

\[
\begin{align*}
\hat{Z}_{\text{turn},t} \times \hat{Z}_{\text{ret},t} & = 8.754 \\
\hat{Z}_{\text{turn},t} \times \hat{Z}_{\text{mret},t} & = 9.876 \\
\hat{Z}_{\text{ret},t} \times \hat{Z}_{\text{mret},t} & = 8.347 \\
\end{align*}
\]

| \(Q(12)\)       | 11.824                                       | 12.321                                       | 11.453                                       |
| \(Q(18)\)       | 13.619                                       | 13.562                                       | 14.312                                       |

\[
\begin{align*}
\hat{Z}_{\text{turn},t} \times \hat{Z}_{\text{ret},t} \times \hat{Z}_{\text{mret},t} & = 6.557 \\
\end{align*}
\]
Table 6. Estimation Results for Individual Stocks that Have neither Overconfidence nor Disposition Effects (Company Code 1102)

| Individual stock turnover (turn<sub>i</sub>) | Individual stock return (ret<sub>i</sub>) | Market return (mret<sub>i</sub>) |
|---------------------------------------------|------------------------------------------|---------------------------------|
| A<sub>1</sub> | 0.0017 * * * | 2.8269 | A<sub>2</sub> | 0.0043 | 0.9764 | A<sub>3</sub> | 0.0015 | 0.5542 |
| B<sub>11</sub> | 0.4496 * * * | 9.1647 | B<sub>21</sub> | 0.1312 | 0.3641 | B<sub>31</sub> | 0.0973 | 0.4341 |
| B<sub>12</sub> | 0.2182 * * * | 4.1234 | B<sub>22</sub> | 0.5888 | 1.5149 | B<sub>32</sub> | 0.3673 | 1.5181 |
| B<sub>13</sub> | 0.0867 * | 1.8237 | B<sub>23</sub> | -1.1977 * * * | -3.4317 | B<sub>33</sub> | -0.6518 * * * | -3.0002 |
| C<sub>11</sub> | 0.0112 | 1.3881 | C<sub>21</sub> | -0.1516 * * | -2.5633 | C<sub>31</sub> | -0.0400 | -1.0872 |
| C<sub>12</sub> | -0.0058 | -0.7194 | C<sub>22</sub> | -0.0126 | -0.2133 | C<sub>32</sub> | -0.0160 | -0.4374 |
| C<sub>13</sub> | -0.0040 | -0.5284 | C<sub>23</sub> | 0.1502 * * * | 2.7021 | C<sub>33</sub> | 0.0826 * * | 2.3867 |
| c<sub>11</sub> | 0.0145 | 1.1990 | c<sub>21</sub> | 0.2387 * * * | 2.6825 | c<sub>31</sub> | 0.0884 | 1.5952 |
| c<sub>12</sub> | 0.0097 | 0.8017 | c<sub>22</sub> | -0.1079 | -1.2150 | c<sub>32</sub> | 0.0377 | 0.6813 |
| c<sub>13</sub> | 0.0114 | 0.9467 | c<sub>23</sub> | -0.1436 | -1.6249 | c<sub>33</sub> | -0.1043 * | -1.8975 |
| F<sub>10</sub> | 0.6636 * * * | 10.6706 | F<sub>20</sub> | 1.4905 * * * | 3.2635 | F<sub>30</sub> | -0.7576 * * * | -2.6648 |
| F<sub>11</sub> | -0.0313 | -0.4423 | F<sub>21</sub> | -0.0749 | -0.1440 | F<sub>31</sub> | 0.7753 * * | 2.3959 |
| F<sub>12</sub> | -0.1706 * * * | -2.3889 | F<sub>22</sub> | -0.6551 | -1.2487 | F<sub>32</sub> | -0.6194 * * | -1.8968 |
| F<sub>13</sub> | -0.0724 | -1.0438 | F<sub>23</sub> | 0.3491 | 0.6856 | F<sub>33</sub> | 0.7927 | 2.5010 |

Conditional Mean Equation

\[ h_{\text{turn, }i}^2 = \epsilon_{\text{turn, }i} / \sqrt{\sum_{i=1}^{n} \epsilon_{\text{turn, }i}^2} \]

\[ h_{\text{ret, }i}^2 = \epsilon_{\text{ret, }i} / \sqrt{\sum_{i=1}^{n} \epsilon_{\text{ret, }i}^2} \]

\[ h_{\text{mret, }i}^2 = \epsilon_{\text{mret, }i} / \sqrt{\sum_{i=1}^{n} \epsilon_{\text{mret, }i}^2} \]

Conditional Co-variance Equation

\[ \nu_{c1,2} = -0.0045 * * * \]

\[ \nu_{c1,3} = 0.5987 * * * \]

\[ \nu_{c2,3} = 0.0199 * * * \]

Goodness-of-Fit Test and Diagnostic Checking

\[ Z_{\text{turn, }i} = \epsilon_{\text{turn, }i} / \sqrt{h_{\text{turn, }i}^2} \]

\[ Z_{\text{ret, }i} = \epsilon_{\text{ret, }i} / \sqrt{h_{\text{ret, }i}^2} \]

\[ Z_{\text{mret, }i} = \epsilon_{\text{mret, }i} / \sqrt{h_{\text{mret, }i}^2} \]

\[ Z_{\text{turn, }i} x Z_{\text{ret, }i} \]

\[ Z_{\text{turn, }i} x Z_{\text{mret, }i} \]

\[ Z_{\text{ret, }i} x Z_{\text{mret, }i} \]

\[ Q(12) \]

\[ Q(18) \]

\[ Q(24) \]

\[ Q(12) \]

\[ Q(18) \]

\[ Q(24) \]

\[ Q(12) \]

\[ Q(18) \]

\[ Q(24) \]

\[ Q(12) \]

\[ Q(18) \]

\[ Q(24) \]
The company codes of stocks that only have the disposition effects and that only have the effect of overconfidence are listed in Table 7. According to the statistical results, it is observed that there are 110 stocks that only have the disposition effect, accounting for 41.985% of the selected stock sample; the stocks that only have the overconfidence effect have a total of 33 stocks, accounting for 12.595% of the selected stock sample. There are obviously more stocks that only have the disposition effect than those that only have the effect of overconfidence.

Table 7. Overview of Individual Stocks (Company Codes) with Only Overconfidence Effects and Only Disposition Effects

| Stocks that only have disposition effect | Stocks that only have overconfidence effect |
|----------------------------------------|--------------------------------------------|
| 1101 1513 2027 2524 0015 9904          | 1103 1517 2029 2526 1210 9917              |
| 1104 1519 2031 2534 1225 9919          | 1108 1521 2032 2535 1231 9924              |
| 1109 1522 2102 2538 1301 9925          | 1110 1524 2107 2607 1402                    |
| 1213 1603 2108 2609 1436               | 1217 1606 2207 2616 1451                    |
| 1218 1609 2308 2701 1614               | 1219 1611 2314 2702 1715                    |
| 1229 1612 2316 2704 2017               | 1233 1616 2323 2705 2204                    |
| 1303 1709 2324 2801 2301               | 1305 1712 2330 2809 2327                    |
| 1307 1713 2344 2820 2331               | 1312 1720 2349 2832 2332                    |
| 1314 1721 2350 2833 2351               | 1315 1731 2361 2838 2354                    |
| 1323 1903 2362 2845 2357               | 1324 1905 2363 2849 2393                    |
| 1326 1909 2371 2903 2401               | 1400 2006 2379 2911 2411                    |
| 1417 2008 2390 2912 2492               | 1423 2009 2417 9908 2536                     |
| 1435 2012 2436 9914 2608               | 1437 2014 2511 9945 2613                     |
| 1463 2023 2515 2901                    | 1512 2025 2520 6191                         |

The company codes of stocks that have both the disposition effect and the overconfidence effect, and the stocks that do not have the disposition effect or the overconfidence effect are listed in Table 8. Among them, there are a total of 110 stocks that have both the disposition effect and the overconfidence effect, which is the same as the stocks that only have the disposition effect, accounting for 41.985% of the selected stock sample; there are only 9 stocks that have no disposition effect or overconfidence effect, accounting for 3.435% of the selected stock samples. It means that almost all of the stocks in the Taiwan stock market have disposition effects or overconfidence effects that affect the individual stock turnover.

Table 8. Overview of Individual stocks (Company Codes) that Have Both the Overconfidence and the Disposition Effects and the Stocks that Do Not Have Overconfidence or Disposition Effect

| Individual stocks that have both overconfidence and disposition effects | Individual stocks that have neither overconfidence nor disposition effects |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 1201 1460 2010 2504                                                    | 1102                                                                     |
| 1215 1464 2013 2601                                                    | 2312                                                                     |
| 1216 1465 2020 2603                                                    | 2325                                                                     |
| 1220 1503 2022 2605                                                    | 2345                                                                     |
| 1227 1504 2033 2610                                                    | 2347                                                                     |
| 1232 1506 2103 2611                                                    | 2353                                                                     |
| 1235 1507 2104 2615                                                    | 2462                                                                     |
| 1304 1514 2105 2854                                                    | 2606                                                                     |
| 1308 1515 2106 2856                                                    | 2612                                                                     |
| 1309 1532 2201 2905                                                    |                                                                          |
| 1313 1605 2206 2906                                                    |                                                                          |
| 1409 1608 2311 2908                                                    |                                                                          |
| 1413 1701 2313 2915                                                    |                                                                          |
| 1416 1702 2315 3052                                                    |                                                                          |
| 1418 1704 2321 5305                                                    |                                                                          |
| 1419 1707 2338 6005                                                    |                                                                          |
| 1434 1710 2355 6012                                                    |                                                                          |
| 1439 1711 2356 9905                                                    |                                                                          |
| 1440 1714 2359 9907                                                    |                                                                          |
| 1443 1716 2360 9910                                                    |                                                                          |
| 1444 1717 2367 9918                                                    |                                                                          |
| 1445 1718 2374 9921                                                    |                                                                          |
| 1447 1802 2383 9927                                                    |                                                                          |
| 1452 1809 2420 9929                                                    |                                                                          |
| 1454 1810 2430 9933                                                    |                                                                          |
| 1455 1904 2431 9937                                                    |                                                                          |
| 1457 1907 2438                                                        |                                                                          |
| 1459 2002 2501                                                        |                                                                          |

Throughout this research sample selection of individual stocks, there are 220 stocks with disposition effects (only 110 stocks with disposition effects plus 110 stocks with both disposition effects and overconfidence effects), accounting for 83.97% of the selected stock samples. There are a total of 143 stocks with overconfidence effect (only 33 stocks with overconfidence effect plus 110 stocks with both overconfidence and disposition effects), accounting for 54.58% of the selected stock samples. In the presence of both the disposition and overconfidence effects, overconfidence behavior still has influence on stock trading of investors. Hypothesis 1(H1) is accepted, i.e., investors still have overconfidence behavior after verifying the influence of overconfidence and disposition effects on trading volumes at the same time.

Based on the above empirical results, it can be found that in the selected individual stock samples, the disposition effect on individual stock turnover is quite significant, which means that most stock investors have a
tendency to sell stocks with current profits, but hold off selling stocks with current losses. This study also found that there are more than half of the individual stocks whose turnover will be significantly positively affected by market returns. That is, it is observed that the investors in these stocks are overconfident due to the increase in the market returns, and will trade more actively in the following period. Therefore, after considering both the effect of disposition and of overconfidence on the individual stock turnover, although the effect of overconfidence on the turnover of individual stocks is not as significant as the effect of the disposition effect, most individual stocks can also observe that investors have overconfidence in trading. This means that investors still have overconfidence after considering the disposition effect on the individual stock turnover in Taiwan stock market.

(2) Verification of Company Risk and Overconfidence Trading

Hypothesis 2(H2): Overconfidence investors tend to underestimate the risks and hold the riskier stocks due to their too much faith in their stock selection ability and trade too many high-risk stocks.

Regarding Hypothesis 2(H2) in this study, the average market value of individual stock companies calculated by the data within the sample period is used as the standard to measure the risk of individual stocks. When the average market value of individual stocks is larger, the risk of the company is greater. When the average market value of individual stocks is smaller, the risk of this company is smaller. After ranking the selected stocks in order of their average market capitalization, the top 50 companies with market capitalization are regarded as low-risk portfolios while the 50 companies with the smallest market capitalization are regarded as high-risk portfolios. In this study, the disposition and overconfidence effects of high-risk and low-risk stocks are verified, and the results are summarized in Table 9.

Based on the statistical results of overconfidence and disposition effects of high-risk and low-risk individual stocks (Table 9), we find that among the low-risk individual stocks, there are 33 stocks with disposition effects, accounting for 66% of low-risk stocks, and 28 stocks with overconfidence effects, accounting for 56% of low-risk stocks, without disposition or overconfidence effects. There are 6 stocks with effect, accounting for 12% of the sample of low-risk stocks. In the part of high-risk stocks, there are 25 stocks with disposition effects, accounting for 50% of high-risk stocks, and 28 stocks with overconfidence effects, accounting for 56% of high-risk stocks, with no disposition or overconfidence effect. There is only one stock of stocks, accounting for 2% of the sample of high-risk stocks.

According to the empirical evidences shown in Table 9, among high-risk stocks, the situation of having disposition effect is more obvious than that of low-risk stocks and more high-risk stocks have disposition effect than those with overconfidence effect. Among the low-risk stocks, however, there are slightly more stocks with overconfidence effect than those with disposition effect.

There are 28 stocks with overconfidence effects in both high-risk stocks and low-risk stocks. High-risk stocks have an overconfidence effect assumed by this research is not true. Therefore, the Hypothesis 2(H2) of this study is not accepted for the situation where low-risk stocks have an overconfidence effect will be less obvious than when high-risk stocks have an overconfidence effect. In this study, under the risk classification standard of individual stock market value, overconfident investors will not obviously tend to trade or hold high-risk (small-market value) stocks. However, it is worth noting that among the low-risk stocks, 6 stocks have no overconfidence effect or disposition effect (Table 9), which is obviously more than high-risk stocks. This means that compared with high-risk stock investors, low-risk stock investors are less likely to have irrationality such as overconfidence behavior or disposition effect. Then, this research can reasonably infer that more rational investors will tend to invest in low-risk (large market capitalization) individual stocks, rather than investing in high-risk (small market capitalization) of individual stocks.

| Individual stocks with disposition effects only | 16 | 21 |
| Individual stocks with overconfidence effects only | 11 | 4 |
| Individual stocks with overconfidence and disposition effects | 17 | 24 |
| Individual stocks that have neither overconfidence nor disposition effect | 6 | 1 |

Table 9. Statistical Results of Deposition and Overconfidence Effects of High-Risk and Low-Risk for Individual Stocks

5. Concluding Remarks

Given that the disposition effect has a similar impact on trading volume as overconfidence, moreover most previous studies have ignored the disposition effect when studying the overconfidence behavior. Therefore, the main purpose of this research is to examine both the overconfidence behavior and disposition effect of investors in the Taiwan stock market. The main findings and conclusions are indicated as follows:

Considering both the effect of disposition and of overconfidence on the individual stock turnover, although the effect of overconfidence on the turnover of individual stocks isn’t less significant than the disposition effect, most individual stocks can also observe that investors have overconfidence in trading. This means that investors are still overconfident after considering the disposition effect on the individual stock turnover in Taiwan stock market.

In this study, under the risk classification standard of individual stock market value, overconfident investors will not obviously tend to hold high-risk (small-market value) stocks. Compared with high-risk stock investors, low-risk stock investors are less likely to have irrationality such as overconfidence behavior or disposition effect.
Then, the study can reasonably infer that more rational investors will tend to invest in low-risk (large market capitalization) individual stocks, rather than investing in high-risk (small market capitalization) of individual stocks.

It is worth noting that the results from our two hypothesis tests, the results give us some senses that under the disposition effect on the individual stock turnover, investors still have overconfidence in the overall data period, which means that investors will overestimate their own capabilities and even own the private information they possess because of their investment profits. In order to continue to maintain this confidence, investors will choose to sell profitable stocks as soon as possible to prove that the profit comes from their own ability, but are reluctant to realize the loss in order to avoid admitting their mistakes in judgment.

In sum, the main findings of this research can help investors/practitioners identify biased trends from overconfidence and/or disposition effect in advance and make investment/hedge strategies accordingly, i.e., such knowledge can help the investors/practitioners to develop strategies and take appropriate measures. The limitation of the study is that the sample in this study is selected for ten years, so the eligible stocks are 262 samples. Future study can consider selecting different sample periods and number of stocks. The results obtained can be verified with this research.

Finally, for this research, it is necessary to recognize the conclusions and suggestions put forward in the text, which are based on the relevant research methods, actual data and empirical model cited in this study. When the follow-up researchers refer to and cite, it is advisable to consider the changes in the time and space environment during the research period, so that it can be applied flexibly in actual situations.

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