

# 交易前透明度、委託單失衡與投資人行為偏誤之關聯性

## The Relationship between Pre-trade Transparency, Order Imbalance and Investors' Behavioral Biases

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**摘要：**本文主要以日資料及高頻率逐筆日內資料探討當揭示資訊更多時是否存在著投資人的行為偏誤以致對市場造成異常影響？實證顯示散戶的委託失衡日內型態大致呈現倒U型，而法人則大致呈現類似W型態的波浪狀，且W型態的高峰點在較透明市場有往前移的現象。另外，散戶在較透明環境的盤中從眾強度會增加，且進一步利用追蹤資料模型與分量迴歸模型發現，散戶與國外法人無論市場是否透明皆有對作的現象，而這情況在透明市場中會發生在較高分位的委託失衡。再者，外資可能因揭示資訊增加更能掌握盤面變化而顯得對本身的決策更加有自信，因為無論是以價或量的指標皆發現其在透明市場的交易更為積極，但另一方面也由其委託失衡之日內型態、下單參與率及委託規模發現他們會很精明的在盤中將委託單分散以避免獨佔資訊在透明市場中迅速外漏。

**關鍵詞：**交易前透明度；下單行為；委託單失衡；從眾；過度自信

**Abstract :** This research analyzes the relationship between pre-trade

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transparency, order imbalance and investors' behavioral biases. The impact of increasing pre-trade transparency on the varied order behavior is determined for three different types of investors: individual investors, domestic and foreign institutional investors. The empirical results show that the intraday pattern of order imbalance for individual investors exhibits an inverse U-pattern, while that for institutional investors displays a quasi W-pattern and the several peak points of the W-pattern move forward in a more transparent market. Additionally, the measure of herding for individual investors increases as market transparency increases and the current order imbalance of individual investors is significantly negatively affected by the previous order imbalance of foreign institutional investors. As foreign traders produce a larger order imbalance, individual investors begin to pay attention. Foreign traders also seem to be more vigorous and confident in a more transparent market. However, they also try to conceal their real motive by using order splitting strategies to avoid information leaks fast according to the intraday pattern of order imbalance and trading activity.

**Keywords :** Pre-trade transparency; Order behavior; Order imbalance; Herding; Overconfidence

## **1.Introduction**

A number of studies have examined the effect of transparency on market performance, but no agreement has been reached (e.g., Boehmer, Saar and Yu, 2005; Madhavan, Porter and Weaver, 2005). Few studies have focused on the relationship between market transparency and investors' behavioral biases. However, the order behavior depends on the investors' perception. Schachter, Andreassen and Gerin (1986) noted that the stock market is a place where people interact, stock price represents "opinions" and any change in opinions is usually associated with the influence of others. As information disclosure is becoming more and more complete, investors can scrutinize others' trading decisions more easily. Investors may have stronger intentions to follow others'

strategies, so herding behavior becomes more significant, or investors may use information to trade in the opposite direction, because of overconfidence. These behavioral biases are likely to have an abnormal impact on the market and may cause orders to show imbalances (Lee, Liu, Roll, and Subrahmanyam, 2004). Without knowledge of the reactions of different market participants, it is difficult to evaluate the complicated effects of transparency enhancement. Both Shefrin (2002) and Kuo (2008) incorporated the common concept of behavioral finance “herding” and “overconfidence” into irrational biases. However, it should be noted that these biases are not necessarily considered to be an error, but an opposing viewpoint based on the rational hypothesis of economists, which is characterized by a psychological behavioral reaction. This research mainly concerns whether investors’ behavioral biases actually exist.

The related literature includes research on market transparency, order imbalance and behavioral biases. Firstly, in terms of market transparency, many studies primarily focus on how market transparency influences each aspect of market quality (e.g., liquidity, transaction cost and the process of price discovery). Theoretical and empirical studies of the impact of transparency have been inconclusive. In terms of theoretical studies, Madhavan (1996) demonstrated that market transparency can increase price volatility and reduce market liquidity in a thin market. Pagano and Röell (1996) studied the price formation process in several stylized trading systems with varying degrees of transparency and observed that, overall, greater transparency results in lower trading costs for uninformed traders, although not necessarily for all trade sizes. In terms of empirical studies, Madhavan, Porter and Weaver (2005) studied the effect of an increase in the pre-trade transparency for the Toronto Stock Exchange and found that volatility and execution costs increase, whereas liquidity decreases. Boehmer, Saar and Yu (2005) studied the impact of increased order book transparency in the New York Stock Exchange (NYSE) and obtained results that were contrary to those obtained for the Canadian market. It was found that greater order flow transparency leads to increased liquidity and reduced trade execution costs. Dong, Han and Li (2006) also studied the effects of improved transparency in China’s A share markets and

found that the market quality improved, as demonstrated by lower volatility, higher market liquidity and improved informative efficiency. Eom, Ok and Park (2007) found that the market quality of the Korea Exchange (KRX) is increasing and is concave in pre-trade transparency, with significantly diminishing returns above a certain point. Chung and Chuwonganant (2009) studied the effect of pre-trade transparency on market quality, using data before and after the introduction of SuperMontage and found that both bid–ask spreads and return volatility declined significantly after the implementation of SuperMontage. Lucarelli, Bontempi and Mazzoli (2010) studied pre-trade transparency in the Italian Stock Exchange in 2007 and showed the role of the order flow disclosure in reducing both the adverse selection component of the bid–ask spread and the “lemons discount” asked by individual investors to negotiate on risky or illiquid stocks. Additionally, in the Taiwanese stock market, Ma, Lin and Chen (2008) found that greater pre-trade transparency intensifies aggressiveness in order placement, reduces extreme order placement by individual investors and changes trader order sizes. However, greater transparency increases volatility, but not liquidity and efficiency. Lin, Ma and Chen (2011) continued to study the effect of transparency on the information content of the limit order book and its effect on order placement strategies. It was found that the best quotes for unexecuted orders for individual traders always contain more information than the average quotes from steps 2 to 5, but this does not apply to institutional investors. Lin (2014) showed that greater transparency enables larger trades to utilize strategic stealth trading to prevent information from quickly leaking by selecting both trade sizes and time intervals.<sup>2</sup>

Most of these studies of transparency focus primarily on market performance but do not consider the influence of transparency on the investor order placement strategies, except those of Boehmer *et al.* (2005), Ma *et al.* (2008), Lin *et al.* (2011) and Lin (2014). Even Boehmer *et al.* (2005) only considered the cancellation rate and the order size, Ma *et al.* (2008) stressed the

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<sup>2</sup> Reference sources: Ma *et al.* (2008), Lin *et al.* (2011) and Lin (2014).



order aggressiveness, Lin *et al.* (2011) stressed the information content of limit order books and Lin (2014) focused mainly on stealth trading strategy. None clarify whether investors' behavioral biases exist in the transparent market and these biases can have an abnormal impact on the market.

Secondly, previous studies considered the origin and autocorrelation of order imbalance and its influence on stock returns, market performance and spread formation. Chordia, Roll and Subrahmanyam (2002), Chordia and Subrahmanyam (2004) and Lee, Liu, Roll and Subrahmanyam (2004) all found that daily order imbalance is significantly positively auto-correlated. Lee *et al.* (2004) further found that the continuous order imbalance for the foreign institutional investors is more significant than for other types of traders and the order splitting or herding behavior of investors can cause continuous order imbalance. With regard to the influence of order imbalance on stock return, Brown, Walsh and Yuen (1997) studied the 20 most active shares on the Australian Stock Exchange and proposed a two-way causal relationship between order imbalance and stock return. However, this relationship was not sustained beyond a single day and its validity was less definite after the current independent variables had been eliminated. In relation to the effect of order imbalance on market performance, Huang and Stoll (1997) used models to demonstrate that intraday price variation is caused by order imbalance. Chan and Fong (2000) further found that part of the Volatility-Volume Relationship is caused by the effect of order imbalance on price variation. Additionally, Chordia *et al.* (2002) found that a greater order imbalance results in a larger spread and lower liquidity. Although order imbalance affects liquidity, it cannot predict the next change of liquidity. Handa, Schwartz and Tiwari (2003) modeled the process of quote setting and price formation in a non-intermediated, order driven market. They found that the location of the bid and offer quotes and the size of the bid-ask spread depend on three things: the difference in the valuation between groups of investors, the proportions of investors in each of the groups and adverse selection.

In summary, past research has focused on the autocorrelation of order imbalance and its influence on stock returns, market performance and spread

formation. No studies consider the related issues of market transparency. In view of this, Liao (2005), Ma, Lin and Liao (2006) and Lin, Ma and Chen (2007) began to study the impact of market transparency on order imbalance, but their main motivation was to determine whether the order imbalances of the different aggressive orders (such as market orders and limit orders) in the less and more transparent market are different. They did not distinguish the directions of order imbalance and discussed the relationship between order imbalance and investors' behavioural biases in detail. Lee *et al.* (2004) found that order imbalance can be a result of herding. Therefore, this study further examines whether this problem is more obvious or reduces with greater information disclosure. Under-confident investors may follow the investment strategy of others to maintain a sense of security. However, over-confident investors may overvalue their own judgments when they have a better grasp of the market.

Thirdly, since research into investors' behavioral biases, Kuo (2008) has shown that for "irrational bias", herding is noticed early. From a psychological point of view, herding is based on insecurity and regret aversion. However, overconfidence is also a psychological bias. Overconfidence is defined a condition whereby individuals evaluate their own characteristics and ability to be greater than the actual level. Shefrin (2002) classified overconfidence into heuristic driven bias. People exhibit biased behavior mostly because of the outside environmental system or limited intelligence. The former are caused by market mechanisms, transaction costs and information asymmetry and this paper explores the scope of these. The following focuses on the literatures related to herding and overconfidence.

In terms of herding behavior, Banerjee (1992) found that following other people's actions and making the same decisions are herding behaviors. Cote and Sander (1997) defined herding as individual investors changing their minds and attempting to approach the market public expectations. Nofsinger and Sias (1999) defined herding as investors having a tendency to rush in the same trading direction during a certain period. Shefrin (2002) classified herding as a frame dependent bias. Hwang and Salmon (2004) noted that herding is

generated by non-fundamental factors. Although there are other definitions, all are derived from the two characteristics: “trading in the same direction” and “following the market”. In addition, Devenow and Welch (1996) classified herding into three categories: external benefit (i.e., Froot, Sharfstein and Stein, 1992 ; Hirshleifer, Subrahmanyam and Titman, 1994), the reputation and agency problem (i.e., Scharfstein and Stein, 1990 ; Maug and Naik, 1998) and information waterfall stream (i.e., Banerjee, 1992 ; Bikhchandani, Hirshleifer and Welch, 1992).

Odean (1998) classified overconfident behavior into three categories: overestimating the information precision (i.e., Kyle and Wang, 1997), overestimating individual abilities and judgment (i.e., Taylor and Brown, 1988 ; Shefrin, 2002) and being overoptimistic. Both overotimism and overestimation of an individual’s own abilities are positive illusions, which is different from overestimating the precision of information (Biais, Hilton, Mazurier and Pouget, 2005). However, all cause investors to be excessively concerned about their information and judgment and ignoring other people’s perspectives in the market to produce more transactions (Odean, 1998). For these different reasons, overestimating the precision of information results in underestimation of the risk and an increase in the willingness of investors to trade (Jaffe and Winkler, 1976). Trusting their own judgment excessively allows investors to undertake more courageous transactions, and overly optimistic investors mistakenly make a higher expected utility, so transactions increase.

In summary, these related studies focus on the definition, the classification or the reason for behavioral biases, but do not consider the relationship between biased behavior and order imbalance. Lee *et al.* (2004) determined the market participants as herding or splitting order by discriminating the autocorrelation of daily order imbalance from sub-samples, “including same traders” and “excluding same traders”. For example, if the autocorrelation of order imbalance from a sub-sample “including same traders” is larger than that from a sub-sample “excluding same traders” but the difference is not significant, it is determined that the investors’ continuous orders result from herding. However, this method may require the exact investor account information and the order

imbalance is only for market orders (i.e., the net order flow resulting from trades that demand immediacy). Additionally, these do not consider pre-trade transparency.

Order flow disclosure on the Taiwanese Stock Exchange has gradually increased, since January 2, 2003, which provides a unique opportunity to empirically determine whether investors are more rational when there is greater pre-trade transparency. This study mainly uses the daily and intraday data to study this issue. The ratio of order imbalance is used to measure the degree of market abnormality and then the concepts of herding and overconfidence are used to determine the change of order imbalance in a transparent market. The empirical results show that the intraday pattern for order imbalance for individual investors exhibits an inverse U-pattern, while that for institutional investors has a quasi W-pattern and the several peak points of W-pattern move forward in a more transparent market. In addition, the order imbalances for individual investors increase as transparency increases and the degree of herding also increases in the middle trading intervals, especially for sellers. A panel data model and quantile regression model are used to determine the interaction between individual investors and institutional investors. The previous order imbalances of foreign institutional investors negatively affect the current order imbalances of individual investors, and this satiation occurs especially in the higher quantile, as the market transparency is raised. Furthermore, either in terms of price or volume indicators, the foreign institutional investors are more aggressive. This result shows that they can increase confidence because they better understand a market with greater transparency. However, they may split their orders in the middle trading intervals to avoid the private information leaks, once again proving the intraday pattern for order imbalance.

## **2. Data and Methodology**

### **2.1 Data**

The sample comprises the 200 stocks of the most active firms listed on the Taiwan Stock Exchange from September 2002 to June 2003. To compare the influence of the different levels of transparency, the sample period covers two stages of increasing transparency, including four months for each stage. This study defines September to December of 2002 as the first stage, the least transparent stage, when only the quote and the volume of the best bid/ask are disclosed (hereafter referred to as the “pre-transparent period”); March to June of 2003 is defined as the second stage, the more transparent period during which the top five prices in the book are revealed together with information on the depth at each price (hereafter referred to as the “post-transparent period”). Because the gap between the first stage and the second stage is about six months, so selecting the later consecutive four months is considered reasonable in the first stage. We do not choose the former two months are due to the market is still in the adjustment period, investors have not yet fully familiar with the market system, hence, it is less appropriate compared to other periods. Furthermore, if the sample period is too late, for example, over June 2003 (the new system has been implemented for more than six months), this research may be affected by other interferences, and can not solely focus on the information disclosure.

The intraday data set contains the complete order book and all of the trades executed from September 2002 to June 2003 during the trading session. The records of each order and trade include information on the price, size, direction, investor type (institutional or individual), and the time-stamped to the nearest one-hundredth of a second. In the intraday analysis, the trading time is divided into nine half-hour intervals, the first running from 9:01 a.m. to 9:30 a.m. and the last comprising the thirty minutes before the closing call. If the intraday interval is too short, the observations may be fewer, while if the intraday

interval is too long, the nature of intraday data may be lost, and therefore an interval of 30 minutes should be appropriate.<sup>3</sup>

## 2.2 Methodology

This section first utilizes the ratios of order imbalance to measure the market abnormality and then determines whether investors' behavioral biases (such as herding and overconfidence) exist when there is greater transparency.

### 2.2.1 Order Imbalance

The ratios of order imbalance (hereafter referred to as the "OIM") are calculated according to the order quantity submitted by specific investors during each 30-min trading interval. Investors are divided into individual investors, foreign institutional investors and domestic institutional investors. The institutional investors comprise the foreign and domestic institutional investors. The calculating processes are shown below:

#### (1) Without Considering the Direction

Initially, Liao (2005), Ma *et al.* (2006) and Lin *et al.* (2007) are referenced to measure the OIM.

$$OIM = \frac{|OrderBuy - OrderSell|}{OrderBuy + OrderSell} \quad (1)$$

where "OrderBuy" is the buying quantity and "OrderSell" is the selling quantity. The numerator is the absolute value of the difference between the two sides. Aktas, Bodt, Declerck and Oppens (2007) noted that the informed trading probability ( $PIN = \frac{\alpha\mu}{\alpha\mu + 2\varepsilon}$ ), demonstrated by Easley, Kiefer, O'Hara and Paperman (1996b), is an approximate measure of orders imbalance ( $\frac{E(|B - S|)}{E(B + S)}$ ). When there is information asymmetry, better-informed traders can manipulate the market price to move it up or down, so the market may

<sup>3</sup> Reference sources: Lin *et al.* (2011) and Lin (2014).

exhibit positive or negative order imbalance. Therefore, although this method can measure the degree of order imbalance, it can not measure the imbalances that result from buy orders or sell orders.

## (2) Considering the Direction

This method removes the absolute value of the numerator from equation (1). If the ratio is greater than 0, the market is defined as a buying order imbalance, otherwise it is defined as a selling order imbalance.

$$OIM' = \frac{OrderBuy - OrderSell}{OrderBuy + OrderSell} \quad (2)$$

After calculating the OIM' for various types of investors during each 30-min trading interval in different transparent markets, a paired-samples t test is used to determine the differences in order imbalance between the pre-transparent period and the post-transparent period.

### 2.2.2 Herding

It must also be determined whether the change in order imbalance and investors' behavioral biases are related. When there is greater information disclose, investors can more clearly observe the trading trends of other traders, so they may abandon their own judgment and follow the lead of others, which can result in a serious order imbalance.

#### (1) Herding Strength

The herding strength is defined with reference to Liu (2006), but the method is amended. This indicator is mainly divided into "buyer herding strength" and "seller herding strength", depending on the trading direction. The former is the percentage of buy orders divided by total orders as the market gathers more buyers. The latter is the percentage of sell orders divided by total orders as the market gathers more sellers. "the market gathers more buyers" is set as an OIM' larger than 0.4, that is, more than 70% of orders in the market are buy orders and less than 30% of orders are sell orders.

#### (2) The Relationship between the Order Imbalance of Individual Investors and Institutional Investors



This section discusses the interaction between individual investors and institutional investors in directional order imbalance. It is determined whether individual investors follow institutional investors and which type of institutional investors they are more likely to follow. The dependent variable is the current order imbalance of individual investors and the independent variable is the lagged order imbalance of institutional investors (lag 1). The panel data model and the quantile regression model are used.

#### a. Panel Data Model

This method is used in order to simultaneously take into account the characteristics of time series and cross sectional analysis. The time series data includes 169 days and 1,521 intraday intervals. The cross sectional data includes 200 firms. Therefore, the daily and intraday analyses contain 33,800 and 304,200 observations, respectively.

$$\begin{aligned} Individual_{it} = & \beta_0 + \beta_1 T + \beta_2 Domestic_{i,t-1} + \beta_3 T \times Domestic_{i,t-1} \\ & + \beta_4 Foreign_{i,t-1} + \beta_5 T \times Foreign_{i,t-1} \end{aligned} \quad (3)$$

In terms of daily analysis (Model 1), "Individual<sub>it</sub>" is the average OIM' for individual investors on day, t. "T" is the dummy variable for transparency. It is assigned a value of 1 if the observations are during the "post-transparent period". "Domestic<sub>i,t-1</sub>" and "Foreign<sub>i,t-1</sub>" represent the OIM' on day t-1 for domestic institutional investors and foreign institutional investors, respectively. "T × Domestic<sub>i,t-1</sub>" and "T × Foreign<sub>i,t-1</sub>" represents the cross multiplied items of the transparency dummy variable and the OIM' for institutional investors. These multiplied items determine whether the OIM' for institutional investors significantly influences that for individual investors when there is greater transparency. "Rm<sub>t-1</sub>" is the market index, and it is the control variable. In addition, the panel data model can be divided into a fixed effects model and a random effects model. The Hausman test, proposed by Hausman(1978), is used to determine which model can be used. The fixed effects mode is used if the test statistic, H, is larger than the critical value; otherwise the random effects model is used.

$$H = (\hat{\beta}_{fixed} - \hat{\beta}_{random}) [Var(\hat{\beta}_{fixed}) - Var(\hat{\beta}_{random})]^{-1} (\hat{\beta}_{fixed} - \hat{\beta}_{random}) \sim \chi^2 \quad (4)$$

In terms of intraday analysis (Model 2), “Individual<sub>it</sub>” is the average OIM’ for individual investors in the interval, t. The remainders of the symbols are similar to those above. Models 1 and 2 include 33,800 and 304,200 observations, respectively.

#### b. Quantile Regression Model

The quantile regression model is used to determine whether there are obvious relationships between the OIM’ for institutional investors and that for individual investors when there is a large order imbalance. This method was first proposed by Koenker and Bassett (1978) and it addresses the shortcomings of the ordinary least squares method (OLS), which only considers the median. Quantile regression provides estimates of the linear relationships between regressors and a specified quantile of the dependent variable. Since this approach does not require strong distributional assumptions, it offers a robust method of modeling these relationships.

### 2.2.3 Overconfidence

Investors may increase confidence because they have a better understanding of a market that has greater transparency. Several measures are used to observe this phenomenon.

#### (1) Inverse Operative Strength

Unlike herding, overconfidence occurs when investors trust their own ability excessively. Therefore, if investors have the courage to buy stocks when most people sell stocks, this shows that they still trust their own judgment, although their views are contrary to those of the market. As cited in Liu (2006), the inverse operative strength is the percentage of buy orders divided by total orders as the market gathers more sellers. “The market gathered more sellers” is set as an OIM’ that is smaller than -0.4. That is, more than 70% of orders in the market are sell orders and less than 30% of the orders are buy orders.

Except for the inverse operative strength, many studies have shown that overconfident investors tend to engage in more aggressive trading (e.g., Benos, 1998; Odean, 1998; Barber and Odean, 2001; Hirshleifer and Luo, 2002). This may manifest itself in several ways, such as increased trading volume, frequent trading, or an order price that is superior to others, in order to fight for the transaction. In view of this, other measures, such as order strength, the percentages of order quantity and order numbers are considered.

### (2) Order Strength

Unlike Ma *et al.* (2008), who divided the order aggressiveness into six categories, according to order price, the method of Lee (2005), which takes into account the price and quantity simultaneously, is used in this section.

$$\text{Buy Order Strength} = \sum_{i=1}^n \frac{Q_{it}^B}{Q_{tL}^{BT}} \times \frac{(P_{it}^B - P_{t-1}^*)}{P_{t-1}^*} \quad (5)$$

$$\text{Sell Order Strength} = \sum_{i=1}^n \frac{Q_{it}^S}{Q_{tL}^{ST}} \times \frac{(P_{t-1}^* - P_{it}^S)}{P_{t-1}^*} \quad (6)$$

$$\text{Order Strength} = (\text{Buy Order Strength} + \text{Sell Order Strength}) / 2 \quad (7)$$

where “ $P_{t-1}^*$ ” is the transaction price at time t-1, “ $P_{it}^B$ ” and “ $P_{it}^S$ ” are the buy order price and sell order price at time t, respectively, “ $Q_{it}^B$ ” and “ $Q_{it}^S$ ” are the buy order quantity and sell order quantity at time t, respectively, “ $Q_{tL}^{BT}$ ” and “ $Q_{tL}^{ST}$ ” are the total buy order quantity and the total sell order quantity between time t-1 and t, respectively and “n” represents the total order numbers within each matching period. Therefore, this method uses order quantity as a weight to measure the order strength. When investors want to trade more actively, the order buying price is increased or the order selling price is decreased, so the larger order strength in equation (7) represents investors becoming more aggressive. Unlike Lee (2005), the measures used in this study must be standardized, because some stocks have higher prices and the others have lower prices. Therefore, for the items on the right of equations (5) and (6), the difference between the order price and transaction price is divided by the transaction price at time t-1.

### (3) The Percentages of Order Quantity and Order Numbers

Similar to the methods of Ma *et al.* (2008), this study observes investors' order aggressiveness purely according to order quantity and order numbers. The percentage of the order quantity is the order quantity for a specific type of investors (such as foreign institutional investors) divided by the total order quantity for all investors. Similarly, the percentage of order numbers replaces order quantity with order numbers. Higher percentages of these two measures indicate that the degree of investors' participation in the market is greater. The average order size is the total order quantity divided by the total order numbers.<sup>4</sup>

## 3. Analysis of Results

The results for order imbalance, herding and overconfidence are presented as follows.

### 3.1 Order Imbalance

Panels A and B of Table 1 list the OIM at each 30-min trading interval for different types of investors during the two transparent periods. Before increased transparency (pre-transparent period), the table shows that the OIM for individual investors lies roughly between 19.27%~30.88%, the OIM for institutional investors lies roughly between 51.47%~57.56% and the OIM for domestic and foreign institutional investors lies between 51.57%~59.62% and 55.4%~58.19%, respectively. After increased transparency (post-transparent period), the table shows that the OIM for individual investors lies roughly between 19.65%~32.3%, the OIM for institutional investors lies roughly between 48.42%~53.54% and the OIM of domestic and foreign institutional investors lies between 50.3%~58.96% and 48.59%~55.67%, respectively. On the whole, the volatility of the OIM for individual investors is higher than that

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<sup>4</sup> Ma *et al.* (2008) only observed the percentage of the order quantity, but both the percentages of order quantity and order numbers are observed in this research. Additionally, the samples, sample periods and the categories of investors are different in the two papers.

for institutional investors. Similarly, Panels A and B of Table 2 list the OIM' (including positive order imbalance and negative order imbalance) at each 30-min trading interval for different types of investors during the two transparent periods. The distribution of the OIM' is roughly the same as that shown in Table 1, but the volatility of the OIM' for individual investors is higher.

Figure 1 and Panels A and B of Table 1 show that the OIM for individual investors exhibits a U-shaped intraday pattern, but that for institutional investors is more irregular but has a W-shaped pattern. It is inferred that individual investors have not received enough information in Interval 1, so they do not make the same decisions and rush to trade at the same time. As time passes the more information they have, the greater is the order imbalance, especially in Interval 6 (11:30~12:00) and Interval 7 (12:00~12:30). As for institutional investors, the W-shaped pattern supports the arguments of Foster and Viswanathan (1994, 1996) and Cao and Willard (2000), who stated that informed traders make active trades early to avoid losing their information advantage and then they tend to conceal or delay their trading strategies, in order to prevent other informed traders from becoming aware of their monopolized information, as the common private information is released gradually. At the last minute, they use all of their monopolized information.<sup>5</sup> Therefore, if institutional investors are the informed traders, they may engage in active trading at the open and close of trading, which results in a serious order imbalance. In addition, if they follow stealthy trading strategies to protect information by splitting orders in the middle trading intervals, the order imbalance may also become more serious. This may explain the several peak points of the W-shaped pattern.

Figure 1 also shows that the peak points of the W-shaped pattern move forward when there is increased transparency. For example, during the pre-transparent period, the highest point of the OIM for institutional investors is in Interval 7 and the second highest is in Interval 9, but the highest point moves

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<sup>5</sup> Refer to Lin (2014).

forward to Interval 4 and the second moves forward to Interval 7 during the post-transparent period. According to Lin (2014), these phenomena may be caused by institutional investors concealing their real motives, in order to avoid information leaks in a transparent market.

Panel C of Tables 1 and 2 shows the differences in order imbalance and the results of a paired-samples t test for the two transparent periods. In daily analysis, the order imbalances for individual and institutional investors have no significant changes in OIM or OIM'. However, the negative OIM' for institutional investors decreases, especially for foreign institutional investors. In terms of intraday analysis, it is found that the OIM' for individual investors increases in a transparent market, particularly in Intervals 2, 4, 7 and 8. The positive OIM' for individual investors is most significant in Interval 5, followed by Intervals 2 and 6. However, the negative OIM' for individual investors increases in the middle intraday intervals, when there is greater transparency, but that for institutional investors decreases, especially in the opening and middle intraday intervals. The positive OIM' for institutional investors increases in Interval 5 and the negative OIM' for domestic institutional investors also increases in Interval 3. It is thought that this phenomenon may result from order splitting during stealth trading. On the whole, Figure 1 and Tables 1 and 2 show that the order imbalance for individual investors increases, but that for institutional investors decreases.

### **3.2 Herding**

Table 3 lists the herding strength and the results of a paired-samples t test for the two transparent periods. Table 3 shows that the herding strength of individual investors increases when there is greater transparency, especially seller herding strength. This phenomenon is consistent with the results shown in Table 2, where the negative OIM' is seen to significantly increase in a transparent market. This may be because individual investors receive a lot of information in a more transparent market, and they prefer to follow other people's views when they realize that they lack capability. This behavior is relatively safe for the individual investors who are averse to high risk, because they are particularly concerned about losses when most people sell. The herding

strength of institutional investors decreases, especially for foreign institutional investors.

**Table 1**  
**The Distribution of Orders Imbalance and the Differences between the Various Transparent Periods**

Table 1 lists the ratio of orders imbalance (OIM) at each 30-min trading interval for different types of investors during the two transparent periods. The Panels A and B represent the ratio that the numerator is the absolute value of the difference between buying quantity and sell quantity, and the denominator is the total order quantity for the specific trading intervals. This table also lists the differences between the various periods in OIM for the given trading intervals. The differences of OIM in Panel C represent the average of OIM on the specific trading interval during the post-transparency period, minus that during the pre-transparency period. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using a paired-samples *t*-test.

**Panel A : Pre-transparent period**

	Individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	15.12%	49.06%	45.97%	51.79%
Interval 1	19.27%	53.67%	53.75%	55.65%
Interval 2	23.73%	51.85%	54.95%	57.46%
Interval 3	26.03%	52.03%	51.57%	55.84%
Interval 4	27.54%	54.26%	55.97%	58.19%
Interval 5	28.73%	54.28%	55.36%	56.42%
Interval 6	29.49%	53.17%	52.48%	55.40%
Interval 7	30.88%	57.56%	59.62%	57.43%
Interval 8	29.77%	51.47%	53.75%	56.04%
Interval 9	23.93%	55.04%	57.10%	56.14%

**Panel B : Post-transparent period**

	Individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	16.04%	47.69%	46.57%	48.29%
Interval 1	19.65%	50.77%	54.13%	53.82%
Interval 2	25.46%	50.04%	52.43%	53.55%
Interval 3	27.28%	50.50%	52.31%	53.90%
Interval 4	29.18%	53.54%	54.95%	54.59%
Interval 5	30.26%	50.62%	56.48%	50.59%
Interval 6	31.55%	48.42%	52.30%	49.82%
Interval 7	32.30%	52.25%	56.59%	53.67%
Interval 8	30.62%	51.24%	52.30%	51.84%
Interval 9	24.32%	51.49%	58.96%	52.79%



<b>Panel C : Differences (Post-transparent period - Pre-transparent period)</b>				
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	0.91%	-1.37%	0.60%	-3.50% **
Interval 1	0.38%	-2.90% **	0.38%	-1.83% *
Interval 2	1.73% **	-1.81%	-2.52% *	-3.91%
Interval 3	1.26%	-1.52%	0.74%	-1.94%
Interval 4	1.64% **	-0.72%	-1.02%	-3.60%
Interval 5	1.53%	-3.66% ***	1.11%	-5.84% ***
Interval 6	2.06%	-4.75% *	-0.18%	-5.58% **
Interval 7	1.41% **	-5.31% ***	-3.04% **	-3.76%
Interval 8	0.85% *	-0.23%	-1.45%	-4.20%
Interval 9	0.39%	-3.55% **	1.86%	-3.35% **

**Table 2**  
**The Distribution of Directional Orders Imbalance and the Differences between the Various Transparent Periods**

Table 2 lists the ratio of directional orders imbalance (OIM') at each 30-min trading interval for different types of investors during the two transparent periods. The Panels A and B represent the ratio that the numerator is the difference between buying quantity and sell quantity, and the denominator is the total order quantity for the specific trading intervals. The other instructions are the same as Table 1. However, for the consistent interpretation, it should be noted that the difference of negative OIM' is calculated by the average of negative OIM' on the specific trading interval during the pre-transparency period, minus that during the post-transparency period, thus if this value is positive represent the negative OIM' increases with greater transparency. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using a paired-samples *t*-test.

<b>Panel A : Pre-transparent period</b>								
	Positive order imbalance				Negative order imbalance			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	15.18%	42.60%	43.75%	50.19%	-14.10%	-47.60%	-45.55%	-52.50%
Interval 1	15.85%	47.41%	50.64%	54.22%	-20.10%	-52.36%	-54.29%	-54.60%
Interval 2	24.84%	50.63%	55.85%	52.74%	-20.63%	-52.64%	-55.85%	-55.86%
Interval 3	28.13%	49.20%	48.32%	55.17%	-23.37%	-46.34%	-52.26%	-52.42%
Interval 4	28.12%	53.22%	55.54%	57.05%	-23.58%	-55.89%	-56.45%	-55.99%
Interval 5	28.27%	49.54%	52.82%	52.73%	-28.14%	-53.41%	-58.62%	-57.95%
Interval 6	30.73%	52.88%	57.08%	53.50%	-27.06%	-52.67%	-52.62%	-53.03%
Interval 7	32.70%	55.16%	61.08%	60.28%	-27.01%	-56.19%	-59.96%	-54.08%
Interval 8	29.40%	51.47%	60.26%	55.63%	-29.97%	-51.87%	-56.85%	-53.59%
Interval 9	23.25%	53.72%	57.52%	54.85%	-22.75%	-54.39%	-55.97%	-52.36%

**Panel B : Post-transparent period**

	Positive order imbalance				Negative order imbalance			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	15.30%	40.78%	43.96%	46.85%	-15.15%	-43.64%	-45.96%	-43.62%
Interval 1	15.82%	43.25%	45.63%	52.13%	-20.73%	-48.80%	-56.85%	-47.02%
Interval 2	26.95%	49.36%	54.62%	50.41%	-24.49%	-48.17%	-52.47%	-50.85%
Interval 3	28.06%	49.50%	49.80%	55.04%	-26.65%	-47.80%	-54.09%	-50.01%
Interval 4	28.32%	52.11%	55.67%	56.33%	-29.36%	-53.19%	-55.68%	-52.80%
Interval 5	31.08%	53.08%	58.30%	57.39%	-29.15%	-48.34%	-56.29%	-46.30%
Interval 6	33.01%	50.17%	50.93%	51.88%	-27.91%	-48.01%	-51.83%	-49.87%
Interval 7	32.71%	47.47%	57.58%	54.74%	-33.03%	-54.71%	-58.85%	-54.51%
Interval 8	28.65%	50.96%	52.22%	53.21%	-31.78%	-48.99%	-53.33%	-53.59%
Interval 9	24.90%	51.96%	59.86%	53.80%	-23.64%	-51.84%	-62.09%	-43.22%

**Panel C : Differences (Post-transparent period - Pre-transparent period)**

	Positive order imbalance				Negative order imbalance			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	0.13%	-1.82%	0.21%	-3.35%	1.05%	-3.96% **	0.41%	-8.88% **
Interval 1	-0.03%	-4.16% **	-5.01% ***	-2.10%	0.63%	-3.56%	2.56%	-7.58%
Interval 2	2.11% *	-1.27%	-1.22%	-2.33%	3.86% **	-4.47% ***	-3.39%	-5.01% **
Interval 3	-0.07%	0.30%	1.48%	-0.14%	3.28% **	1.46%	1.83% *	-2.42%
Interval 4	0.20%	-1.11%	0.14%	-0.72%	5.78% ***	-2.70%	-0.76%	-3.19%
Interval 5	2.81% **	3.54% *	5.48% *	4.66%	1.01%	-5.08% **	-2.33% *	-11.65% ***
Interval 6	2.28% *	-2.71%	-6.15% *	-1.62%	0.85%	-4.66%	-0.79%	-3.16%
Interval 7	0.02%	-7.70% ***	-3.50% *	-5.54%	6.02% ***	-1.48%	-1.10%	0.43%
Interval 8	-0.74%	-0.51%	-8.03%	-2.42%	1.82%	-2.88%	-3.51%	0.00%
Interval 9	1.65%	-1.76%	2.34%	-1.06%	0.89%	-2.56% *	6.11%	-9.15% **

Table 4 further uses the panel data model to determine whether individual investors follow institutional investors and which type of institutional investors that they are more likely to follow. This table also uses the quantile regression model to determine whether there are obvious relationships between the OIM' for institutional investors and that for individual investors, when there is a greater order imbalance. It is found that the current order imbalance for individual investors is significantly affected by the previous order imbalance for institutional investors and that the coefficient is negative. That is, individual investors buy stocks when institutional investors sell stocks and vice versa.

**Table 3**  
**The Herding Strength for Buyers and Sellers**

T Table 3 lists the herding strength and the results of paired-samples t test during the two transparent periods are also listed. Herding strength is mainly divided into "buyer herding strength" and "seller herding strength", depending on the trading direction. The former is the percentage of buy orders divided by total orders as the market gathers more buyers. The latter is the percentage of sell orders divided by total orders as the market gathers more sellers. "the market gathers more buyers" is set as an OIM larger than 0.4, that is, more than 70% of orders in the market are buy orders and less than 30% of orders are sell orders. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using a paired-samples t-test.

**Panel A : Pre-transparent period**

	buyer herding strength				seller herding strength			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	69.30%	78.13%	78.65%	81.98%	67.92%	79.98%	81.45%	83.62%
Interval 1	69.06%	80.58%	81.40%	82.64%	69.63%	83.39%	82.66%	84.65%
Interval 2	72.93%	81.60%	83.56%	85.91%	70.19%	83.02%	83.92%	83.27%
Interval 3	74.03%	80.78%	81.87%	83.36%	71.69%	81.59%	83.18%	81.50%
Interval 4	74.39%	83.98%	83.50%	83.60%	71.38%	83.00%	85.20%	83.49%
Interval 5	74.43%	82.38%	82.63%	83.00%	72.89%	84.34%	84.49%	84.63%
Interval 6	73.92%	82.44%	82.58%	82.46%	72.32%	83.41%	82.97%	84.97%
Interval 7	74.96%	83.96%	85.15%	84.64%	73.04%	84.81%	83.99%	84.09%
Interval 8	74.22%	82.76%	85.80%	83.73%	73.64%	83.05%	83.27%	84.04%
Interval 9	73.00%	82.75%	83.68%	83.55%	71.17%	83.63%	82.34%	85.01%

**Panel B : Post-transparent period**

	buyer herding strength				seller herding strength			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	68.88%	78.41%	79.24%	81.85%	68.57%	78.29%	80.17%	81.55%
Interval 1	70.25%	80.43%	82.91%	82.43%	69.35%	81.94%	83.43%	80.84%
Interval 2	72.65%	81.33%	83.95%	84.32%	71.05%	81.09%	82.98%	83.29%
Interval 3	73.73%	82.51%	83.34%	85.34%	73.23%	81.18%	82.68%	84.02%
Interval 4	73.89%	81.38%	82.62%	83.90%	73.74%	83.17%	83.15%	81.94%
Interval 5	75.00%	83.25%	84.33%	85.54%	73.06%	82.33%	82.90%	81.93%
Interval 6	76.33%	80.95%	83.05%	84.07%	73.91%	80.14%	83.78%	80.60%
Interval 7	75.20%	81.80%	84.46%	82.60%	74.44%	82.31%	83.64%	83.60%
Interval 8	75.08%	82.10%	83.10%	84.62%	73.50%	82.09%	83.28%	85.06%
Interval 9	73.71%	83.65%	85.28%	85.16%	72.25%	82.61%	84.67%	81.96%

Panel C : Differences (Post-transparent period - Pre-transparent period)								
	buyer herding strength				seller herding strength			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	-0.41%	0.28%	0.59%	-0.13%	0.65% *	-1.68% **	-1.28% *	-2.07% **
Interval 1	1.18%	-0.15%	1.51%	-0.21%	-0.28%	-1.45%	0.77%	-3.81% ***
Interval 2	-0.28%	-0.27%	0.39%	-1.59% **	0.86%	-1.93% *	-0.95%	0.02%
Interval 3	-0.30%	1.73%	1.47%	1.97%	1.55% **	-0.42%	-0.50%	2.52%
Interval 4	-0.50%	-2.60% **	-0.88%	0.30%	2.37% **	0.17%	-2.05% *	-1.55%
Interval 5	0.57%	0.88%	1.70%	2.54% *	0.17%	-2.01% *	-1.59%	-2.71% **
Interval 6	2.40% **	-1.49% *	0.48%	1.61%	1.59% **	-3.27% **	0.81%	-4.37% **
Interval 7	0.24%	-2.16% **	-0.69%	-2.04% **	1.40% **	-2.49% **	-0.35%	-0.49%
Interval 8	0.86%	-0.66%	-2.70% *	0.89%	-0.13%	-0.96%	0.01%	1.02%
Interval 9	0.72%	0.89%	1.60%	1.62%	1.08% *	-1.02%	2.34% *	-3.04% *

**Table 4**  
**The Empirical Results of the Panel Data Model**

Table 4 displays the empirical results of the panel data model. This model simultaneously takes into account the characteristics of time series and cross sectional analysis. The time series data includes 169 days and 1,521 intraday intervals. The cross sectional data includes 200 firms. Hence, the daily and intraday analyses contain 33,800 and 304,200 observations, respectively.

"Individual<sub>it</sub>" is the average OIM of individual investors in the day *t*. "T" is the dummy variable of transparency, and it is assigned the value of 1 if the observations are during the "post-transparent period". "Domestic<sub>(i,t-1)</sub>" and "Foreign<sub>(i,t-1)</sub>" represent the OIM in day *t-1* for domestic institutional investors and foreign institutional investors, respectively. "Rm<sub>(t-1)</sub>" is the market index, and it is arranged as the control variable. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using *t*-test. In addition, the panel data model can be divided into the fixed effects model and the random effects model. The Hausman test, proposed by Hausman(1978), is used to determine which model can be used.

	Model 1 (daily)		Model 2 (Intraday)	
	coefficient	<i>t</i> value	coefficient	<i>t</i> value
constant	1.4393 *	1.6979	5.6446 ***	8.3718
T	-0.0100	-0.4759	-0.0160	-0.8145
domestict-1	-0.0890 ***	-5.0868	-0.0733 ***	-6.5933
T×domestict-1	0.0279	1.1565	0.0206	1.3465
foreignt-1	-0.0995 ***	-6.5972	-0.1534 ***	-13.0453
T×foreignt-1	-0.0457 ***	2.6435	-0.0419 **	2.1132
Rmt-1	-1.5527 ***	-3.8884	-1.7723 ***	-5.8522
R-squared	0.2092		0.1852	
Chi-Sq. Statistic (Hausman Test)	15.3665 ***		12.3634 ***	

**Figure 1**  
**The Intraday Patterns of Orders Imbalance during the Various Transparent Periods**

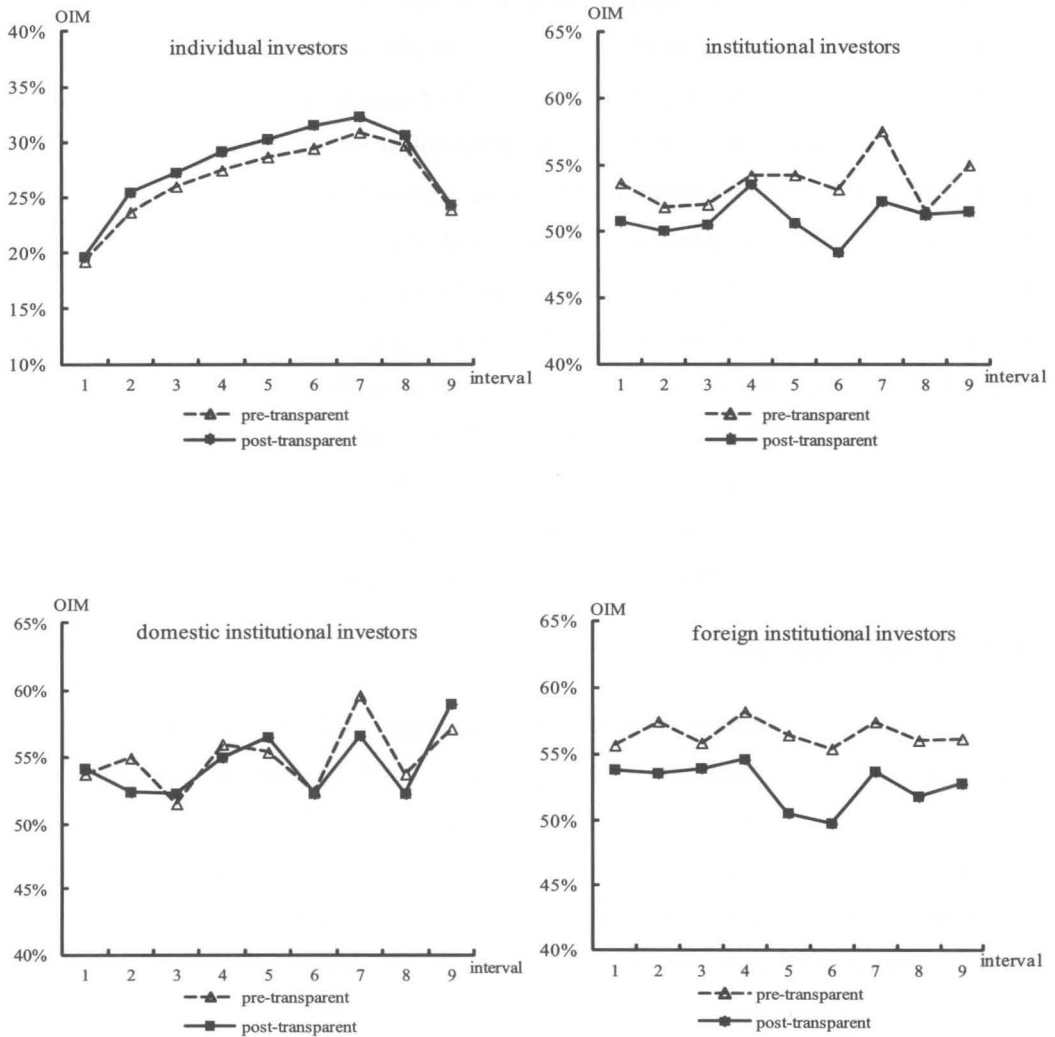


Figure 1 is drawn according to Table 1. This figure exhibits the intraday patterns of orders imbalance during the various transparent periods. The horizontal axis includes nine intraday intervals and each interval covers 30 minutes.

More specifically, there is no obvious relationship between the OIM' for domestic institutional investors and that for individual investors, but the relationship between the OIM' for foreign institutional investors and that for individual investors is significantly negative. This may be due to either capital

or information. Foreign institutional investors have an advantage over individual investors, so regardless of whether the market is transparent, individual investors only realize that it is time to buy stock when foreign institutional investors sell stock and make a profit, so many individual investors usually buy based on the highest price which results in a delay.

In Table 5 the order imbalance for individual investors is divided into four quantiles, at 0.2, 0.4, 0.6 and 0.8. The table shows that the negative relationship between the OIM' for domestic institutional investors and that for individual investors does not change for different quantiles of order imbalance. However, the negative relationship between the OIM' for foreign institutional investors and that for individual investors occurs in the higher quantiles, such as those at 0.6 and 0.8. This may be because foreign institutional investors have more funds and information than individual investors, which causes individual investors to follow, so they react to the order behavior when foreign institutional investors make large transactions that affect the volume and price in the market.

### **3.3 Overconfidence**

The inverse operative strength, order strength and the percentages of order quantity and order numbers are separately used to measure overconfident behavior. Table 6 lists the inverse operative strength and the results of a paired-samples t test for the two transparent periods. The inverse operative strength of individual investors decreases during the post-transparent period. In general, the probability that individual investors follow the views of others because of uncertainty about investment decisions is relatively higher. Consistent with the herding behavior for individual investors in Table 3, it is seen that most follow the trend in Table 6. In addition, in terms of either daily analysis or intraday analysis, the inverse operative strength of institutional investors increases significantly, especially for foreign institutional investors. The results show that institutional investors are more confident about their decisions because they have a better understanding of other people's willingness in a transparent market. Excessive trust in their own judgment results in more

active transactions (Hirshleifer and Luo, 2002). This phenomenon is verified in Figure 2, Tables 7 and 8.<sup>6</sup>

**Table 5**  
**The Empirical Results of the Quantile Regression Model**

Table 5 utilizes the quantile regression model to explore whether there are obvious relationships between the OIM of institutional investors and that for individual investors under the greater order imbalance or not. The order imbalance for individual investors is divided into four quantiles, at 0.2, 0.4, 0.6 and 0.8. The other instructions are the same as Table 4.

Model 1 (daily)	QR (0.2)		QR (0.4)		QR (0.6)		QR (0.8)	
	coefficient	t value	coefficient	t value	coefficient	t value	coefficient	t value
constant	0.0197	1.6233	0.0149 *	-1.7689	-0.0091	0.7712	0.0241 *	1.8538
T	-0.0313 *	-1.8274	-0.0149	-1.0041	-0.0091	-0.6199	0.0253	1.1199
domestic <sub>t-1</sub>	-0.1234 ***	-4.2766	-0.0636 ***	-3.0230	-0.1083 ***	-4.6652	-0.1788 ***	-8.7394
T×domestic <sub>t-1</sub>	0.0603 *	1.7412	0.0109	0.3268	0.0768	0.6152	-0.1008	-1.1500
foreign <sub>t-1</sub>	-0.1235 ***	-4.3534	-0.1097 ***	-7.1510	-0.1086 ***	-5.9692	-0.1326 ***	-7.1901
T×foreign <sub>t-1</sub>	-0.0247	-0.6807	-0.0435 *	-1.6599	-0.0600 **	-2.2372	-0.0604 **	-2.1757
Rm <sub>t-1</sub>	-0.0146 **	-2.4313	-0.0842 ***	-3.1134	-0.0151 ***	-2.7972	-0.0190 ***	-3.5414
R-squared	0.2017		0.2263		0.1750		0.1651	

Model 2 (Intraday)	QR (0.2)		QR (0.4)		QR (0.6)		QR (0.8)	
	coefficient	t value	coefficient	t value	coefficient	t value	coefficient	t value
constant	0.2078 ***	3.2052	0.0397 ***	4.7539	0.1196 ***	2.9088	0.4812 ***	5.2761
T	-0.0564	-1.5397	-0.0182	-1.1454	-0.0397	-1.2066	-0.0452	-1.4164
domestic <sub>t-1</sub>	-0.0933 ***	-6.2739	-0.0892 ***	-6.5277	-0.0905 ***	-5.4219	-0.0488 **	-2.2815
T×domestic <sub>t-1</sub>	0.0567	1.5680	0.0533	1.1788	0.0373 *	1.7271	0.0200	0.6919
foreign <sub>t-1</sub>	-0.1777 ***	-11.6997	-0.1725 ***	-11.8559	-0.2031 ***	-12.4113	-0.1893 ***	-8.0207
T×foreign <sub>t-1</sub>	-0.0187	-0.8976	-0.0325	-1.5737	-0.0131 **	-2.2598	-0.0502 *	-1.7590
Rm <sub>t-1</sub>	-0.0111 ***	-2.9469	-0.0244 ***	-6.1268	-0.0314 ***	-7.7796	-0.0222 ***	-3.2153
R-squared	0.1095		0.1099		0.1132		0.1024	

<sup>6</sup> The empirical result that institutional investors become more aggressive when there is greater transparency is consistent with the findings of Ma, *et al.* (2008). However, the samples, sample periods and the measure of order aggressiveness are different in the two papers.



**Table 6**  
**The Inverse Operative Strength**

Table 6 lists the inverse operative strength and the results of paired-samples t test during the two transparent periods. The inverse operative strength is the percentage of buy orders divided by total orders as the market gathers more sellers. "The market gathered more sellers" is set as an OIM that is smaller than -0.4. That is, more than 70% of orders in the market are sell orders and less than 30% of the orders are buy orders. The differences of the inverse operative strength in Panel C represent the average of inverse operative strength on the specific trading interval during the post-transparency period, minus that during the pre-transparency period. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using a paired-samples t-test

**Panel A : Pre-transparent period**

	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	32.14%	19.86%	18.25%	16.18%
Interval 1	30.26%	16.70%	17.45%	14.35%
Interval 2	29.78%	17.08%	16.78%	16.73%
Interval 3	28.05%	17.94%	16.23%	17.00%
Interval 4	28.38%	16.88%	15.20%	16.06%
Interval 5	26.96%	15.52%	15.06%	15.94%
Interval 6	27.22%	16.34%	16.98%	15.83%
Interval 7	26.93%	15.13%	16.58%	15.87%
Interval 8	26.13%	16.22%	16.27%	15.90%
Interval 9	28.45%	16.49%	16.04%	14.54%

**Panel B : Post-transparent period**

	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	31.58%	23.06%	20.27%	18.92%
Interval 1	30.73%	18.63%	16.36%	18.09%
Interval 2	28.92%	18.73%	16.59%	17.89%
Interval 3	26.72%	18.21%	16.63%	15.45%
Interval 4	26.39%	16.27%	16.08%	17.56%
Interval 5	26.70%	17.75%	16.68%	18.50%
Interval 6	26.06%	19.63%	16.30%	18.97%
Interval 7	25.38%	17.09%	15.74%	16.67%
Interval 8	26.46%	18.13%	16.53%	13.61%
Interval 9	27.61%	17.09%	14.11%	19.03%

**Panel C : Differences (Post-transparent period - Pre-transparent period)**

	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	-0.56%	3.20% **	2.01% **	2.75% ***
Interval 1	0.47%	1.93% *	-1.09%	3.74% **
Interval 2	-0.87% *	1.65%	-0.19%	1.17%

Interval 3	-1.34% **	0.27%	0.41%	-1.56%
Interval 4	-1.99% **	-0.60%	0.88%	1.50%
Interval 5	-0.25%	2.23% **	1.62% *	2.56% **
Interval 6	-1.16% **	3.29% **	-0.68%	3.14% **
Interval 7	-1.55% **	1.95%	-0.85%	0.80%
Interval 8	0.33%	1.90%	0.26%	-2.29%
Interval 9	-0.84% *	0.61%	-1.93%	4.49% **

**Table 7**  
**The Order Strength and Order Size**

Table 7 lists the order strength and order size for different types of investors by using the equation (7). The larger order strength indicates the more aggressive trading. In addition, the average order size is the total order quantity divided by the total order numbers. The differences of order strength and order size in Panel C represent the average of order strength and order size on the specific trading interval during the post-transparency period, minus that during the pre-transparency period. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using a paired-samples *t*-test.

**Panel A : Pre-transparent period**

	Order strength				Order size			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	0.0712	0.0272	0.0039	0.0417	7.40	46.42	82.75	27.50
Interval 1	0.0675	0.0119	-0.0055	0.0182	7.55	57.39	91.91	35.84
Interval 2	0.0535	0.0138	-0.0022	0.0212	7.16	45.13	78.17	24.85
Interval 3	0.0498	0.0244	0.0025	0.0334	7.13	40.23	70.25	20.83
Interval 4	0.0538	0.0282	0.0019	0.0338	7.29	37.30	65.18	19.88
Interval 5	0.0597	0.0318	0.0071	0.0503	7.09	36.87	64.87	21.63
Interval 6	0.0627	0.0398	0.0056	0.0404	7.12	37.16	63.81	21.08
Interval 7	0.0749	0.0469	0.0112	0.0558	7.11	36.80	56.95	22.15
Interval 8	0.0877	0.0517	0.0134	0.0540	6.69	38.63	61.48	22.47
Interval 9	0.1373	0.0509	0.0118	0.0490	7.24	51.51	71.80	37.54

**Panel B : Post-transparent period**

	Order strength				Ordre size			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	0.0648	0.0460	0.0055	0.0771	8.79	36.94	64.71	24.10
Interval 1	0.0400	0.0202	-0.0043	0.0235	9.17	43.35	60.63	28.31
Interval 2	0.0399	0.0264	0.0014	0.0344	8.57	36.39	53.59	18.65
Interval 3	0.0427	0.0401	0.0023	0.0498	8.22	32.94	52.41	21.10
Interval 4	0.0516	0.0483	-0.0006	0.0580	8.28	32.45	55.11	21.10
Interval	0.0591	0.0529	0.0070	0.0596	8.23	31.12	52.08	19.20

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Interval 6	0.0643	0.0748	0.0104	0.1109	8.39	29.53	55.17	17.49
Interval 7	0.0803	0.0828	0.0094	0.1078	8.13	28.52	48.29	17.62
Interval 8	0.0869	0.0853	0.0137	0.0980	7.94	30.44	47.90	20.45
Interval 9	0.1514	0.0723	0.0268	0.0815	9.02	45.73	69.58	31.81

**Panel C : Differences (Post-transparent period - Pre-transparent period)**

	Order strength				Order size			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	-0.0063	0.0187 **	0.0016	0.0354 ***	1.38 **	-9.48 ***	-18.04 ***	-3.40 **
Interval 1	-0.0275 ***	0.0083	0.0012	0.0052	1.61 *	-14.05 ***	-31.28 ***	-7.53 ***
Interval 2	-0.0137 *	0.0126 *	0.0036 *	0.0132 **	1.41 *	-8.74 ***	-24.58 ***	-6.20 ***
Interval 3	-0.0071 *	0.0157	-0.0002	0.0164 **	1.10	-7.29 ***	-17.84 ***	0.27
Interval 4	-0.0021	0.0200	-0.0025 *	0.0242 ***	0.99	-4.84 *	-10.07	1.23
Interval 5	-0.0006	0.0212 *	-0.0001	0.0093	1.15 **	-5.75 **	-12.80 **	-2.43 **
Interval 6	0.0016	0.0351 ***	0.0048 **	0.0705 ***	1.27 **	-7.64 *	-8.64 *	-3.59 **
Interval 7	0.0054	0.0359 ***	-0.0018	0.0519 ***	1.01	-8.28 **	-8.66	-4.53 **
Interval 8	-0.0008	0.0336 ***	0.0003	0.0440 ***	1.26	-8.20 **	-13.58 ***	-2.02
Interval 9	0.0141	0.0214 **	0.0150	0.0325 ***	1.78 ***	-5.77 *	-2.23	-5.73 *

**Table 8****The Percentages of Order Quantity and Order Numbers**

Table 8 lists the percentages of order quantity and order numbers for different types of investors. The percentage of order quantity is the order quantity for a specific type of investors (such as foreign institutional investors) divided by the total order quantity of all investors. Similarly, the percentage of order numbers replaces order quantity with order numbers. The higher the percentages of these two measures indicate that the degree of investors' participation in the market is higher. The differences of percentages in Panel C represent the average of percentages on the specific trading interval during the post-transparency period, minus that during the pre-transparency period. \*\*\*/\*\*/\* indicates significance at the 1%/5%/10% level using a paired-samples *t*-test.

**Panel A : Pre-transparent period**

	The percentage of order quantity				The percentage of order numbers			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	83.87%	16.13%	10.18%	5.95%	94.75%	5.25%	1.32%	3.93%
Interval 1	87.58%	12.42%	9.72%	2.71%	96.96%	3.04%	1.13%	1.91%
Interval 2	84.81%	15.19%	10.89%	4.30%	95.02%	4.98%	1.45%	3.53%
Interval 3	83.69%	16.31%	10.73%	5.58%	93.76%	6.24%	1.53%	4.71%
Interval 4	81.71%	18.29%	10.60%	7.69%	93.92%	6.08%	1.58%	4.49%
Interval 5	80.71%	19.29%	10.98%	8.31%	92.00%	8.00%	1.75%	6.26%
Interval 6	80.04%	19.96%	10.30%	9.66%	91.92%	8.08%	1.57%	6.52%

Interval 7	79.59%	20.41%	9.80%	10.60%	90.76%	9.24%	1.61%	7.63%
Interval 8	80.18%	19.82%	9.17%	10.65%	91.49%	8.51%	1.44%	7.08%
Interval 9	81.10%	18.90%	7.39%	11.51%	91.87%	8.13%	1.02%	7.11%

**Panel B : Post-transparent period**

	The percentage of order quantity				The percentage of order numbers			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	78.86%	21.14%	10.16%	10.98%	92.28%	7.72%	1.87%	5.85%
Interval 1	84.44%	15.56%	9.60%	5.96%	94.75%	5.25%	1.42%	3.83%
Interval 2	80.41%	19.59%	12.13%	7.46%	92.06%	7.94%	2.18%	5.76%
Interval 3	77.06%	22.94%	11.16%	11.78%	91.01%	8.99%	2.42%	6.57%
Interval 4	75.36%	24.64%	11.79%	12.85%	90.22%	9.78%	2.44%	7.34%
Interval 5	74.97%	25.03%	12.21%	12.81%	89.42%	10.58%	2.37%	8.20%
Interval 6	74.08%	25.92%	12.35%	13.56%	88.44%	11.56%	2.65%	8.91%
Interval 7	74.03%	25.97%	11.41%	14.56%	87.20%	12.80%	2.31%	10.49%
Interval 8	74.19%	25.81%	11.09%	14.71%	88.00%	12.00%	2.21%	9.79%
Interval 9	76.32%	23.68%	10.13%	13.55%	89.35%	10.65%	1.50%	9.15%

**Panel C : Differences (Post-transparent period - Pre-transparent period)**

	The percentage of order quantity				The percentage of order numbers			
	individual investors	institutional investors	domestic institutional investors	foreign institutional investors	individual investors	institutional investors	domestic institutional investors	foreign institutional investors
Daily	-5.01% ***	5.01% ***	-0.02%	5.03% ***	-2.46% **	2.46% **	0.55%	1.91% **
Interval 1	-3.13%	3.13%	-0.11%	3.25% *	-2.22% **	2.22% **	0.29%	1.92% *
Interval 2	-4.40% **	4.40% **	1.24%	3.16% *	-2.95% **	2.95% **	0.73% *	2.22% **
Interval 3	-6.63% ***	6.63% ***	0.42%	6.20% ***	-2.75% **	2.75% **	0.89% **	1.85% *
Interval 4	-6.35% ***	6.35% ***	1.19%	5.16% ***	-3.70% ***	3.70% ***	0.85% **	2.85% ***
Interval 5	-5.74% *	5.74% *	1.23%	4.50% **	-2.57% **	2.57% **	0.63%	1.95% *
Interval 6	-5.96% ***	5.96% ***	2.06% **	3.90% ***	-3.48% ***	3.48% ***	1.08% **	2.40% ***
Interval 7	-5.56% *	5.56% *	1.60%	3.96% **	-3.56% **	3.56% **	0.70%	2.86% ***
Interval 8	-5.99% ***	5.99% ***	1.93% **	4.06% **	-3.49% ***	3.49% ***	0.78% *	2.71% **
Interval 9	-4.78% **	4.78% **	2.74% **	2.04% **	-2.52% **	2.52% **	0.48%	2.03% **

Table 7 simultaneously takes into account the order price and quantity and lists the order strength and order size for different types of investors. Panel C of this table shows that the order strength of individual investors does not change obviously, except for the downward trend in Intervals 1, 2 and 3. This may be

due to individual investors being calmer in the opening intervals, when there is more information disclosure and it is no longer unwise to fight transactions with high cost orders. However, the order strength of institutional investors is significantly increased, especially in the middle and closing intervals, and their order size decreases. This is probably related to stealth trading. If institutional investors conceal themselves by splitting orders or delaying their trading strategies, in order to prevent other informed traders from becoming aware of their monopolized information, they use all of their monopolized information at the last minute.

Table 8 lists the percentages of order quantity and order numbers for different types of investors. The increased range in the percentages of order quantity and order numbers for foreign institutional investors is larger than that for domestic institutional investors. This result shows more frequent participation by foreign institutional investors in a transparent market. Additionally, it is also found that the order strength of foreign institutional investors is higher than that of domestic institutional investors, as seen in Table 7. This result shows that foreign institutional investors are the leaders in price and volume because of their advantages in terms of funds and information.

In sum, this research provides three measures for overconfidence: the inverse operative strength, the order strength and the percentages of order quantity and order numbers. Individual investors are not found to exhibit overconfidence and their order strategy is more conservative than that of institutional investors, depending on the order strength. However, these measures are only slightly significant for domestic institutional investors, so there is insufficient evidence to confirm whether they are overconfident. Foreign investors' trading activity is quite frequent in a transparent market, which means that the probability of overconfidence is greater for foreign institutional investors than for domestic institutional investors. It must be noted that foreign institutional investors are not identified as irrational investors because they are overconfident. In fact, according to Figure 2 and Tables 7 and 8, although their trading activity is quite frequent, they are also very shrewd and split orders in the middle trading intervals, in order to avoid the leak of

monopolistic information in a transparent market. This result validates the stealth trading hypothesis proposed by Barclay and Warner (1993) and the empirical results of Lin (2014)

**Figure 2**  
**The intraday patterns of trading activity during**  
**the various transparent periods**

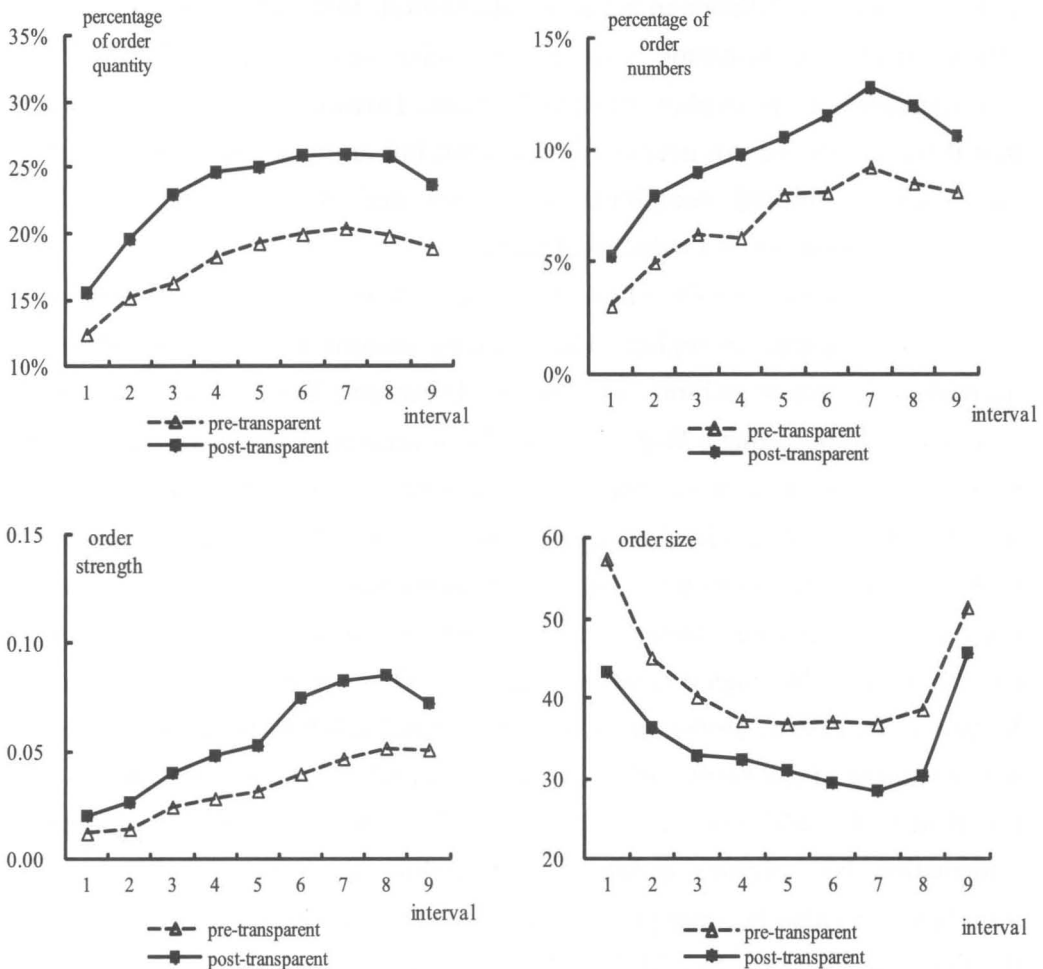


Figure 2 is drawn according to Tables 7 and 8. This figure exhibits the intraday patterns of several measures such as the percentages of order quantity and order numbers, average order strength and order size during the various transparent periods. The horizontal axis includes nine intraday intervals and each interval covers 30 minutes.

## 4. Conclusion

This research mainly uses daily and intraday data to determine whether investors are more rational when there is greater pre-trade transparency. The ratio of order imbalance is used to measure the degree of market abnormality and then the concepts of herding and overconfidence are used to determine the change in order imbalance in a transparent market. Both Shefrin (2002) and Kuo (2008) used the common concept of behavioral finance “herding” and “overconfidence” to explain irrational biases. However, it should be clarified that these biases are not necessarily an error, but an opposing viewpoint that is based on a rational economic hypothesis and it is characterized by a psychological aspect of a behavioral reaction.

The empirical results show that the volatility of order imbalance for individual investors is higher. The intraday pattern for order imbalance for individual investors exhibits an inverse U-pattern, but that for institutional investors exhibits a quasi W-pattern and the several peak points of the W-pattern move forward in a more transparent market. This means that individual investors have not received enough information at the opening, so they do not make the same decisions and rush to trade at the same time. As time passes, the increased information results in an order imbalance. As for institutional investors, the W-shaped pattern supports the arguments of Foster and Viswanathan (1994, 1996) and Cao and Willard (2000). They may engage in active trading at the open and close of trading, which results in a serious order imbalance. In addition, if they use stealth trading strategies to conceal information by splitting orders in the middle trading intervals, the order imbalance can also become greater. This may explain the several peak points of the W-shaped pattern. In addition, the order imbalance for individual investors increases when there is greater transparency and the degree of herding also increases in the middle trading intervals, especially for sellers. This may be because individual investors receive a lot of information in a more transparent market and they prefer to follow other people's lead when they realize that they



are not so capable. This behavior is relatively safe for the individual investors, who are averse to high risk, because they particularly worry about losses when most people sell orders.

The panel data model and quantile regression model are also used to determine the interaction between individual investors and institutional investors. The previous order imbalances of foreign institutional investors negatively affect the current order imbalances of individual investors and this occurs especially in the higher quantile as the market transparency increases, possibly because foreign institutional investors have more funds and information than individual investors, which has an influence on individual investors, and they react to order behavior when foreign institutional investors make large transactions that affect the volume and price in the market. Furthermore, either in terms of price or volume indicators, foreign institutional investors are more aggressive. The results show that they have increased confidence because they have a better understanding of a market that is more transparent. They may also try to conceal their real motives by following order-splitting strategies, in order to avoid information leaks in a more transparent market, depending on the intraday pattern for order imbalance and trading activity.

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