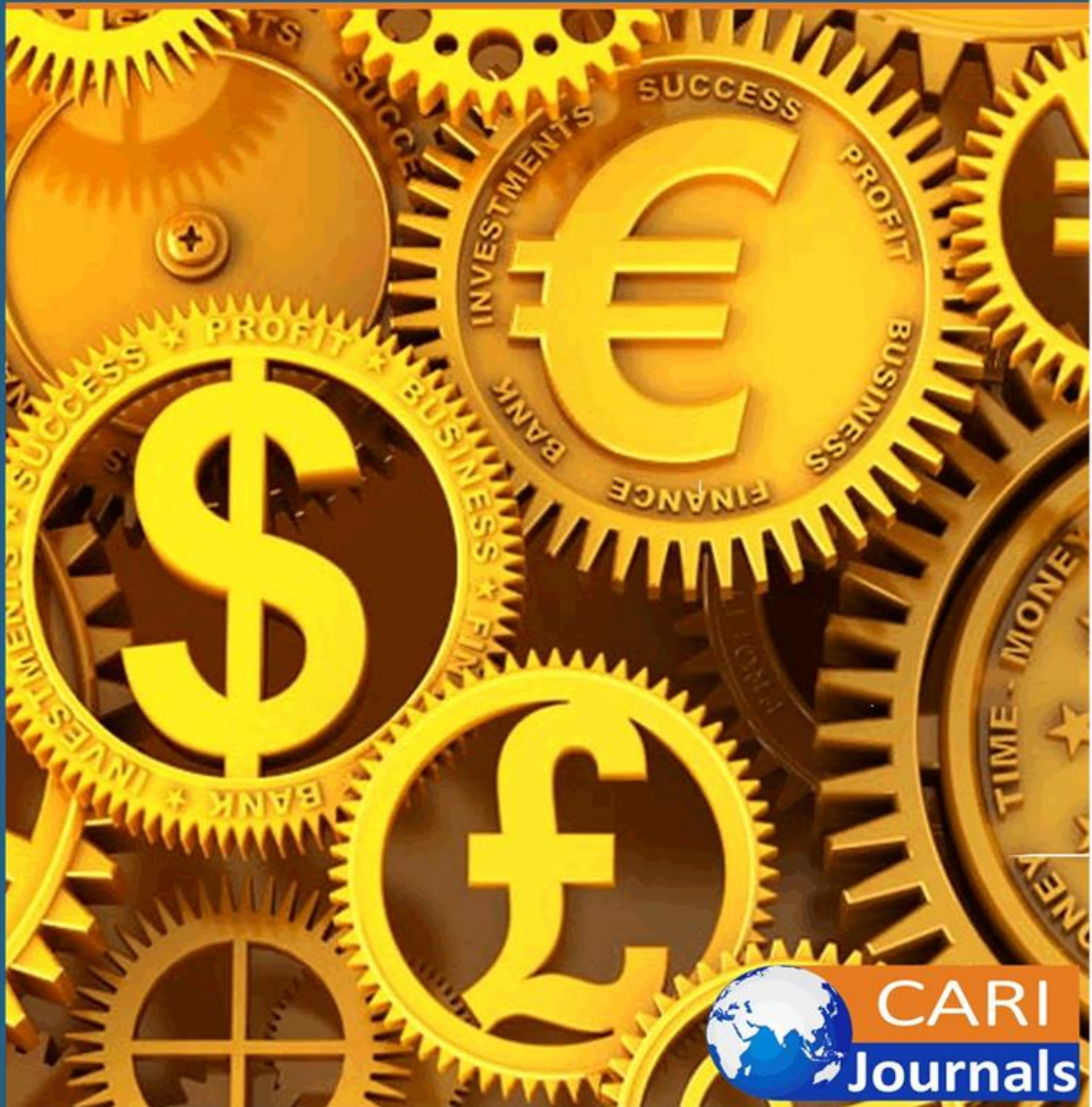
International Journal of
Finance
(IJF)

Transparency, Trading Information and Price Discovery: Evidence from an Emerging Stock Market



CARI Journals

International Journal of Finance

ISSN 2520-0852 (Online)

Vol. 10, Issue No. 8, pp. 90 - 108, 2025

www.carijournals.org

Transparency, Trading Information and Price Discovery: Evidence from an Emerging Stock Market

[1]Shih-Ping Chang, [2*]Cheng-Huei Chiao, [3]Chiou-Fa Lin

[1]PhD Candidate: National Kaohsiung University of Science and Technology

[2]Professor: Craig School of Business, Missouri Western State University

https://orcid.org/0009-0006-1675-9312

[3]Professor: School of management, National Formosa University

Accepted: 29th Nov, 2025, Received in Revised Form: 10th Dec, 2025, Published: 24th Dec, 2025

Abstract

Purpose: This study examines the effects of an incremental transparency event on the trading information and price discovery.

Methodology: The weighted price contribution (WPC) and the weighted price contribution per trade (WPCT) are used to measure trading information; the methodology of Hasbrouck(1991b) is applied in measuring price discovery.

Findings: We compile evidence that the transparency event prevents price manipulation especially at the last trading interval for large firms, raises private information ratio and reduces public information ratio by impounding more trade-related component into price for all sized firms.

Unique Contribution to Theory, Practice and Policy: We investigate the effects of a higher post-trade transparency, using the same stocks in the same market structure. This study provides a complement to the existing post-trade transparency literature. The implications of our results are that the transparency event is helpful for market fairness, efficient market and price discovery.

Keywords: *Transparency, WPC, WPCT, Price Discovery*

1.0 Introduction

Transparency refers to what and how much information market participants should have during the trading process. The heart of debates about transparency lies on fairness among various investors, inter-market competition, and the speed and precision of new information reflected in stock price. There are two different dimensions to transparency: pre-trade and post-trade transparency. Most of the existing literature focuses on pre-transparency impacts[1], however, little is on post-transparency issues, being lack of real data or changed event. In this study, we investigate how a higher post-transparency event affects market quality in a fully electronic, automated, order-driven market[2]. Specifically, we investigate the effects of a higher post-trade transparency on trading information and price discovery, using the same stocks in the same market structure. For these issues, trading information is critical for financial markets in incorporating accurate information into stock price (Fama, 1970); price discovery is one of the most important functions of asset pricing (O'Hara, 2003). The transparency plays a central role in these two processes. This study also provides a complement to the existing post-trade transparency literature[3].

However, theoretical studies related to transparency topic include those by Admati and Pfleiderer (1991), Paul (1993), Madhavan (1995, 1996), Baruch (2005), Frutos and Manzano (2005, 2014), Boulatov and Thomas (2013), Han and Yang (2013), and Tang (2014), to name a few. These studies found that the transparency does affect trading cost, stock liquidity, return volatility, and price informativeness, but the effects are mixed. Empirical studies include those by Board and Sutcliffe (1996), Gemmill (1996), Porter and Weaver (1998), Bloomfield and O'Hara (1999), Flood et al. (1999), Boehmer et al. (2005), Madhavan et al. (2005), Cao et al. (2009), Riordan and Storkenmaier (2012), Degryse et al. (2014), and Chiou and Serrano (2024) etc., where it has been found that transparency matters but the effects are complicated. In a word, there has been little consensus reached in theoretical and empirical literature on the impact of transparency on market

[1] See, for example, Bloomfield and O'Hara (1999), Flood et al. (1999), Madhavan et al. (2005), Boehmer et al. (2005), Baruch (2005), Cao et al. (2009), Boulatov and Thomas (2013), and Tang (2014), etc.

[2] Beginning on January 2, 2003, after each trade, the Taiwan Stock Exchange (TSEC) disclosed another four best bids/asks and their corresponding orders from the original one best bid/ask with orders.

[3] The existing literature examining post-trade transparency includes Board and Sutcliffe (1996), Gemmill (1996), Porter and Weaver (1998), Frutos and Manzano (2005), Riordan and Storkenmaier (2012), etc.

quality. As for regulators, for example, the U.S. Security and Exchange Commission (1994) and U.K. Office of Fair Trading (1994), most of them believed that a higher transparency will increase market quality, upgrading efficiency and fairness.

The empirical study requires an exogenous and obvious change in trading reporting system. The Taiwan Stock Exchange Company (TSEC) 's opening of more bids/asks and their corresponding orders matches this requirement. This disclosure reformation was a pure microstructure event, not under the control of the firms' management. Any alteration in market quality around this event was thus external, rather than arising from the leakage of inside information about a firm's future prospects. Because the needs of various participants and the ongoing evolution of stock trading mechanism, the transparency is still a valuable issue nowadays. And our study at least has three contributions to the existing transparency issues. First, the TSEC's experience in more opening of limit-order books is a blueprint for electronic, automated, order-driven markets world-wide, which has implications for them. Second, the study issues of trading information and price discovery are related to market fairness and asset pricing, respectively. The change of them around the event will give us references how transparency impacts market quality through alteration of these functions. Third, the differences in the effects of a higher transparency on different sized firms are investigated. Madhavan (1996) pointed out that differently sized firms should fit different transparency conditions. Hence, we categorize the sample firms into two equal groups according to their market capitalization and then examine this viewpoint.

This study supports the argument that transparency matters in the sense that it has impacts on trading information and price discovery. The impact on trading information implies that the transparency event prevented informed traders from manipulating stock prices during the last trading period. Regarding the price discovery, meaning that more private information is impounded into price by trade for large and small firms. That is to say, the transparency change forces both sized firms toward strong form efficient market. All in all, this study's findings are consistent with the arguments that transparency promotes market fairness and accelerates stock price toward its true value. These results are consistent with Pagano and Roell (1996), Bloomfield and O'Hara (1999), and Flood et al. (1997b).

The remainder of the paper is organized as follows. Section 2 gives a description of the TSEC.

Section 3 describes the literature Review and hypotheses in the study. Data sources, sampling methodology and sample point filtering are discussed in Section 4. Section 5 describes and explains research methodology. The empirical results and their economic meanings are provided in Section 6, and the final section concludes the paper.

2.0 Institutional Description of the TSEC[4]

The TSEC is a classical order-driven market. Orders are matched fully by computerized trading system. The TSEC trades five days (Monday-Friday) a week, except on national holidays, from 9:00 a.m. to 1:30 p.m. each day. The investors can submit their orders to the system from 8:30 a.m., but they are not executed before 9:00 a.m. Each day, the TSEC decides the stocks' opening price through matching the largest bid and ask orders. After the market opens, the continuous trading rule is applied. At the last 5 minutes, each day, the call method is implemented again to set the close price. Besides, there is a price limit of ±10% from the previous trading day's close price on the TSEC.

The incremental transparency event of January 2, 2003, is a critical feature on the TSEC. Before that date, the transaction price, transaction volume, and only one best bid/ask with orders is disclosed after each trade. Beginning from the day, January 2, 2003, the TSEC disclosed another four best bids/asks with orders. Basically, this is an increment of post transparency. The officials of TSEC argued that this change would promote transparency[5].

Individuals are the major investors on the TSEC. According to statistics[6], the percentage of trading volume by individuals to total market volume was 80% for the year 2003. However, this percentage has decreased gradually. Year 2023, the percentage fell to 57.95%, but individuals are still the majority of punters. They have limited ability to distinguish between true and false information, often being directed by groundless rumors and sentiment. Thus, individuals are thought to be uninformed or noise traders (Bange, 2000; Sias et al., 2006).

[4] The information about the institutional description section is referred to Lin and Chiao (2020), another paper of ours.

[5] See 2003 Fact Book of the TSEC.

[6] See the TSEC's annual reports.

3.0 Literature Review and Hypothesis development

This paper is most closely related to previous studies examining the impact of transparency and the opening of the limit-order books. In the theoretical literature, Admati and Pfleiderer (1991) presented a model that demonstrated that sunshine trading will increase the information content of the price. Frutos and Manzano (2005, 2014) proved that trade disclosure raises the accuracy of traders' expectations about a firm's liquidation value and thus promotes price information efficiency, and that less information is impounded into a price in an opaque market, reducing transaction price efficiency. Baruch (2005) exhibited that more information is revealed through price in an open limit-order books. Madhavan et al. (2005) thought it possible that informed traders would trade more accurately in a transparent system, speeding up the process of price discovery. On the other hand, Paul (1993), Han and Yang (2013) argued this free access to information might delay private information production thereby harming market efficiency. Boulatov and Thomas (2013) argued that it is hidden liquidity that attracts informed traders to trade, and when informational rents are shared among insiders, price discovery is faster in opaque markets. In summary, there is no consensus about the effects of transparency.

The empirical literature is almost based upon examining pre-trade transparency or the visibility of limit-order books before a trade. The overall results suggest that disclosure is relevant, but the effects are complex. Bloomfield and O'Hara (1999) and Flood et al. (1999) used an artificial experiment, rather than real stock market transaction data, to study a dealer market. They obtained no consistent conclusions about transparency versus opaque stock markets. After the NYSE launched its open limit-order book policy, Boehmer et al. (2005) found smaller deviations in transaction prices from the efficient price and the market to be less subject to overshooting and reversal. Cao et al. (2009) found that the best bid/ask prices provide most of the information for price discovery, with little information afforded beyond the bid/ask prices. Degryse et al. (2014) found that dark trading is harmful to liquidity. Using NASDAQ data, Chiou and Serrano (2024) found that improved post-trade transparency would reduce the quoted and percentage spreads. Other studies related to the issues of transparency have discussed algorithmic trading and reduced latency. Hendershott et al. (2011) and Riordan and Storkenmaier (2012) found the changes alter the components of price discovery. In short, there is little consensus among the results obtained

from theoretical frameworks or empirical studies. Given the existing literature and based on our study issues, the following hypotheses are developed.

H1. Post-trade transparency has no effect on trading information.

H2. Post-trade transparency has no effect on price discovery.

4.0 Data[7]

Our data are from the Taiwan Economic Journal (TEJ) database. The real-time transaction data from the TSEC, for the period from October 1, 2002 to March 31, 2003, are used. A number of criteria are used in selecting the sample for this study. First, the firms listed on the TSEC must have survived from the end of 2001 to March 31, 2003. Second, we delete those observations with either bid or ask prices that are non-positive or the difference between the ask price and the bid price is non-positive. Third, we delete ticks that have had no trades. Fourth, those trades and quotes that have been time-stamped outside the regular TSEC trading time are also excluded.

To conduct this study, we sorted the firms listed on the TSEC based on their 2001 year-end capitalization, dividing them equally into two groups. The first group includes stocks that have large capitalization and the second one is composed of stocks having small capitalization. The statistical simple random sampling approach is used to randomly select 50 firms from the first group and 50 from the second group for a total 100 firms in our sample: the first 50 sub-sample firms are called large firms, and the second 50 sub-sample firms are called small firms. The sample set includes 1,815,183 observations during the sample period. The firms in the sample, both large firms and small firms, are distributed across various industries listed on the TSEC, so are fairly representative of the stock market.

When the TSEC began to disclose the best five bids/asks with their corresponding orders is naturally the event day, January 2, 2003. The period, from October 1, 2002 to December 31, 2002, is called the estimation period (before the event); the period from January 1, 2003 to March 31, 2003, is called the event period (after the event). Until now, there has been no rule for determining the lengths of the estimation period and the event period. Our requirement is that the event must be obvious, well- known to investors, and not disturbed by other events. Fortunately, during our

[7] See footnote 4.

sample period, no other major events happened which affected the TSEC, allowing us to compare the market performance for the same stocks traded in the same market but with different post transparency levels.

5.0 Methodology

The measures used in this study are described below.

5.1 Weighted price contribution

The weighted price contribution (WPC) is the amount of new information incorporated into stock price during a given period[8]. It is the ratio of return during a period over the return that happens on that day. French and Roll (1986) argued that price discovery is related to the trading process, hence we divide the open-to-close time into five sub-periods: 9:00-9:30, 9:30-11:30, 11:30-12:00, 12:00-13:00, and 13:00-13:30. The first period, 9:00-9:30, is used to capture overnight information. The last period, 13:00-13:30, contains some private information that may appear as the closing time nears. For each day and each period i, the WPC_i is defined as

$$WPC_i = \sum_{s=1}^{S} \left(\frac{|ret_s|}{\sum_{s=1}^{S} |ret_s|} \right) * \left(\frac{ret_{i,s}}{ret_s} \right) , \qquad (1)$$

where $\mathrm{ret}_{i,s}$ is the return of stock s during period i, ret_s is the open-to-close return of stock s on that day, and we take the natural log returns. Then, the term $\frac{\mathrm{ret}_{i,s}}{\mathrm{ret}_s}$ is the relative contribution of period i, and the first term of wpc_i is the weight for stock s. The mean of wpc_i is calculated for all days. The difference in wpc_i between before and after the event is tested.

5.2 Weighted price contribution per trade

To measure the new information per trade, we divide the wpc_i by the weighted trades happening in period i. We call this weighted price contribution per trade (WPCT)[9], which is calculated by

$$WPCT_i = \frac{WPC_i}{\left(\sum_{s=1}^{S} \left(\frac{|ret_s|}{\sum_{s=1}^{S} |ret_s|} \right) * \left(\frac{t_{i,s}}{t_s} \right) \right)} , \qquad (2)$$

where $t_{i,s}$ is the number of trades occurring during period i for stock s, and t_s is the sum of

[8] See Barclay, M. J., and T. Hendershott, 2003.
[9] See footnote 7.

trades for stock s that happen on that day. The mean of $wpct_i$ is calculated for all days. The difference in $wpct_i$ between before and after the event is tested.

5.3 Components of efficient price change

In the literature, there are two methodologies commonly used to measure the components of efficient price change, both developed by Hasbrouck, in 1991b and then in 1995. The latter method involves observing information shares of a stock from various markets, using a time series approach. In this study, Hasbrouck's earlier model, 1991b, is used to infer the components of price discovery surrounding the event date of January 1, 2003. Following this model, all stock price movements are associated with trade (trade-related) and unassociated with trade (quote-related). Hendershott et al. (2011) pointed out that the price movements are thought to release private information when they are associated with trades; otherwise are considered to reflect public information if they are unassociated with trades. The full model is as follows[10]:

$$r_t = \sum_{i=1}^{3} \alpha_i r_{t-i} + \sum_{i=0}^{3} \beta_i x_{t-i} + \varepsilon_{rt} \ , \qquad (3)$$

$$x_t = \sum_{i=1}^{3} \delta_i r_{t-i} + \sum_{i=1}^{3} \eta_i x_{t-i} + \varepsilon_{xt} \ ,$$

In model (3), the first equation is the trade-by-trade evolution of the bid-ask midpoint; the second one is the persistence of the order flow. The x_{jt} formulates an indicator variable for stock j in trade t, and its value is +1 (for buying) or -1 (for selling). The r_{jt} is the log return based upon the bid-ask midpoint for stock j in trade t, while $\text{var}(\varepsilon_{rt}) = \sigma_r^2$, $\text{var}(\varepsilon_{xt}) = \sigma_x^2$ are supposed to be held. Using tick-by-tick data, these two equations are estimated by OLS for each day and each stock. Basing on some assumptions, the vector auto-regression (VAR) of equation (3) can be inverted into a vector moving average (VMA) form

$$y_t = \begin{bmatrix} r_t \\ x_t \end{bmatrix} = \begin{bmatrix} a(L) & b(L) \\ d(L) & e(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{rt} \\ \varepsilon_{xt} \end{bmatrix} . \qquad (4)$$

According to Hasbrouck (1991b), $a(L)$, $b(L)$, $d(L)$, and $e(L)$ are the lag polynomial operators. The sum, $a(L)\ \varepsilon_{rt} + b(L)\ \varepsilon_{xt}$, is the permanent impact of an innovation on the price. Under the

[10] Following Hasbrouck (1991b), the lagging three periods are used.

assumption that cov(ε_{rt}, ε_{xt})=0, then the variance of the random-walk component can be written as follows:

$$\sigma_{\omega}^{2} = \left(\sum_{i=0}^{\infty} a_i\right)^2 \sigma_r^2 + \left(\sum_{i=0}^{\infty} b_i\right)^2 \sigma_x^2. \quad (5)$$

Following Hasbrouck (1991b), the first term of equation (5) measures the private information part of the efficient price change (or price discovery), and the second term captures the public information part. We divide each part by the total (σ_{ω}^{2}) to infer the ratio of private information and the ratio of public information.

5.4 Robust test for information ratios

To better understand the relative importance of private information versus public information around the incremental transparency event, we apply the methodology used by Hendershott et al. (2011) and Riordan and Storkenmaier (2012) to run a regression with controlled variables. Essentially, this is a robustness test. The controlled variables include: turnover rate, which means trading shares/outstanding shares (in thousands) for stock *i* on day *t*; volatility, defined as the difference between the highest price and lowest price at each day for stock *i*; share price, which is the natural log of the average trading price for stock *i* on day *t*; market value, which is the natural log of market value for each stock on each day. The regression model is

$$L_{i,t} = \alpha_i + \beta_i Dummy_{i,t} + \sum_{K=1}^{4} \Psi_K Controls_{i,t,K} + \varepsilon_{i,t} \ , \quad (6)$$

where $L_{i,t}$ is the public information ratio or the private information ratio of price discovery for stock *i* on day *t*; $Dummy_{i,t}$ is an indicator variable, whose value is 0 if before the event and 1 otherwise; $\varepsilon_{i,t}$ is an error term, assuming the classical assumptions are satisfied; and $Controls_{i,t,\kappa}$ are the control factors.

6.0 Empirical findings

This section describes the basic statistics of our sample and the empirical findings obtained in this study.

6.1 Descriptive statistics

Table 1 shows the descriptive statistics for the small and large stock portfolios. The table reports the price, volatility, turnover rate, outstanding shares (in thousands), and market value (in millions)

for each portfolio. Examining the stocks in each portfolio, we find that the stocks traded in the large portfolio tend to have a higher mean price than that those traded in the small portfolio. The situation is similar for the standard deviation value and the patterns are similar for other variables

Table 1 Summary Statistics

Variable	Unit	Mean	StdDev	Max	Min
Panel A: Large firms					
Price	NTD	40.86	36.52	230.00	4.28
Volatility	NTD	1.55	1.60	20.00	0.00
Turnover	%	1.22	1.70	18.94	0.00
Outstanding Shares	1000 Shares	1477910.91	286954.03	18622886.00	84150.00
Market Value	Million NTD	48651.91	126222.70	996324.00	4072.00
Panel B: Small firms					
Price	NTD	10.56	5.92	33.60	0.56
Volatility	NTD	0.40	0.32	3.00	0.00
Turnover	%	0.89	1.50	28.44	0.00
Outstanding Shares	1000 Shares	162001.75	185753.59	1289656.00	39203.00
Market Value	Million NTD	1165.39	552.95	3761.00	179.00

This table reports the mean, standard deviation, maximum and minimum for the daily values for price, volatility, turnover rate, outstanding shares, and market values in the samples. The sample comprises 100 stocks listed on the TSEC, including for 50 large firms and 50 small firms. The observation period is from October 1, 2002 to March 31, 2003. Price is the mean of the closing price. Volatility is the gap between the highest price and the lowest price. Turnover is the ratio of traded shares/outstanding shares. Market capitalization is the product of the closing price and outstanding shares. NTD is the abbreviation for New Taiwan Dollars.

6.2 Changes in weighted price contribution

The pre- and post-event WPCs during various trading periods are reported in

Table 2. Two primary findings emerge. First, the declining WPC reflects the truce that the first two trades of the day are the most informative because of their accumulation of the overnight information. Second, after the event, there is a significant decrease in the WPC in the last trading period for large firms, but not for small firms. Large investors and institutional traders often prefer to trade in the stocks of large firm. They are usually considered to be informed traders, and the transparency event prevented them from manipulating stock prices during the last trading period. This type of manipulation usually takes place on the TSEC during the last trading period[11]. The mitigation of price manipulation is beneficial to making market fairer than before.

Table 2 Weighted price contribution by trading period

Periods	Before event (A)	After event (B)	Diff. (B)-(A)
Panel A: Large firms			
09:00-09:30	32.46	34.65	2.19
09:30-11:30	31.36	32.86	1.50
11:30-12:00	4.84	6.61	1.77
12:00-13:00	12.04	11.51	-0.53
13:00-13:30	19.21	14.59	-4.62***
Panel B: Small firms			
09:00-09:30	33.61	34.41	0.80
09:30-11:30	30.12	30.43	0.31
11:30-12:00	4.20	4.24	0.04
12:00-13:00	9.52	10.34	0.82
13:00-13:30	20.47	18.18	-2.29

This table reports the weighted price contribution for various trading periods before and after the transparency event. For period i, the weighted price contribution is calculated for each day, then averaged across days. The formula is as follows:

$$WPC_i=\sum_{s=1}^{S}\left(\frac{|ret_s|}{\sum_{s=1}^{S}|ret_s|}\right)*\left(\frac{ret_{i,s}}{ret_s}\right) ,$$

[11] Hsieh (2015) also found that pre-closing information disclosure, launched on 20 February, 2012, decreased price manipulation during the closing period (13:25-13:30).

where $ret_{i,s}$ is the return in period i for stock s, and ret_s is the open to close return for a trading day for stock s. Differences that are significantly different from 0 are denoted by *, ** and *** at significance levels of 10%, 5%, and 1%, respectively.

6.3 Changes in weighted price contribution per trade

We use the WPCT to measure trading information per trade during various trading periods. The results are reported in Table 3. The outcomes are very similar to those in Table 2, that is, with the exception of during the last trading period for large firms, the differences in the WPCTs are insignificant around the transparency event. For large firms, there is a significant decrease in the WPCT during the last trading period, implying the informed traders may have been deterred after the transparency event. This result matches and reinforces the second finding, as shown in Table 2. In a word, our results do not reject H1 except for the last trading period for large firms.

Table 3 Weighted price contribution per trade

Periods	Before event (A)	After event (B)	Diff. (B)-(A)
Panel A: Large firms			
09:00-09:30	2.24	2.41	0.17
09:30-11:30	0.70	0.74	0.04
11:30-12:00	0.47	0.64	0.17
12:00-13:00	0.60	0.56	-0.04
13:00-13:30	1.69	1.28	-0.41***
Panel B: Small firms			
09:00-09:30	1.96	1.91	-0.05
09:30-11:30	0.71	0.72	0.01
11:30-12:00	0.48	0.50	0.02
12:00-13:00	0.53	0.60	0.07
13:00-13:30	1.41	1.34	-0.07

This table reports the weighted price contribution per trade (WPCT) for various trading time periods for the sample firms before and after the transparency event. For time period i, the WPCT is calculated for each day, then averaged across days. The WPCT formula is as follow:

$$WPCT_i = \frac{WPC_i}{\left(\sum_{s=1}^{S}\left(\frac{|ret_s|}{\sum_{s=1}^{S}|ret_s|}\right)*\left(\frac{t_{i,s}}{t_s}\right)\right)}$$

where $t_{i,s}$ is numbers of trades for period i on day t for stock s, and t_s is the sum of $t_{i,s}$ across all trading periods on day t. Differences that are significantly different from 0 are denoted by *, ** and *** indicating significance levels of 10%, 5%, and 1%, respectively.

6.4 The relative importance of efficient price change

We further discuss the private information and public information in relation to price discovery around event. We follow Hasbrouck's (1991b) methods and decompose price discovery or efficient price change into two parts, private information and public information. See Table 4 for the ratio of private information to total information and the ratio of public information to total information pre- and post-event. We find that both large and small firms experience an increase in the private information ratio after the event. On the other hand, there is a decrease in the public information ratio after the event. For both large and small firms, these outcomes imply that under incremental transparency more private information is impounded into price through trade (Hendershott et al., 2011), and lesser public information is reflected in stock. The results also reject H2. Combining above empirical results, we find that transparency is beneficial to market fairness, efficient market and price discovery.

Table 4 Ratios of private and public information

Private information ratios			
	Before Event (A)	**After Event (B)**	**Diff. (B)-(A)**
Large Firms	2.18	3.41	1.23***
Small Firms	4.66	5.67	1.01***
Public information ratios			
Large Firms	97.82	96.60	-1.22***
Small Firms	95.34	94.33	-1.01***

This table reports the ratios of private information and public information before and after the event. The period before the event ranges from October 1, 2002 to December 31, 2002. The period after the event ranges from January 2, 2003 to March 31, 2003. The private information and public

information are measured using Hasbrouck's method (1991a, 1991b). The numbers in columns (A) and (B) are the means before and after the event, respectively. The numbers in the last column are the difference between before and after the event. Values that are significantly different from 0 are denoted by *, ** and *** indicating significance at the 10%, 5%, and 1% levels, respectively.

6.5 Multivariate tests on the information ratios

Incremental transparency may not be the only factor affecting above the information ratio results. Past studies suggest that price discovery may possibly be related to turnover rate, return volatility, price, and market value (Hendershott et al., 2011; Riordan and Storkenmaier, 2012). If these factors are not considered, then the results may be spurious. Therefore, we use the methodology of Hendershott et al. (2011), and Riordan and Storkenmaier (2012), as in equation (6), to make our analysis more complete and rigorous. For convenience of expression, we focus on the dummy variable estimates and their corresponding *t* values. The results are shown in Table 5. After determination of incremental transparency, we see that the private information ratios are significantly positive and the public information ratios are significantly negative for both large and small firms when considering the controlled variables. All in all, the results in Table 5 are consistent with the analysis presented above.

Table 5 Multivariable test for the private information ratio and public information ratio

Dependent variables	Independent variables				
	Turnover rate	Volatility	Share price	Market value	Dummy
Panel A: Large firms					
Private Information ratio	0.63*** (1.96)	-0.52*** (-4.46)	-3.37 (-1.31)	3.24 (1.30)	1.09*** (6.30)
Public Information ratio	-0.63*** (1.96)	0.52*** (4.46)	3.37 (1.31)	-3.24 (-1.30)	-1.09*** (-6.30)
Panel B: Small firms					
Private Information ratio	-8.07* (1.91)	6.29 (1.35)	-5.79 (-0.91)	-1.63 (-0.21)	0.64*** (2.82)
Public Information ratio	8.41* (-1.90)	-6.36 (-1.30)	6.31 (0.95)	0.94 (0.11)	-0.64*** (-3.10)

This table reports regression results for both the private information ratio and public information ratio in relation to control variables. The pre-event period is from October 1, 2002 to December 31, 2002. The post-event period is from January 2, 2003 to March 31, 2003. Regression is performed on daily measures for each stock. The regression model is formulated as follows: $L_{i,t}=\alpha_i + \beta_i Dummy_{i,t} + \sum_{\kappa=1}^{4} \psi_\kappa Controls_{i,t,\kappa}+\varepsilon_{i,t}$, where $L_{i,t}$ is the ratio of private information or the ratio of public information for stock i at time t; $Controls_{i,t,\kappa}$ are the control factors including four variables: turnover rate, which means trading shares/outstanding shares (in thousands) for stock i on day t; volatility, defined as the difference between the highest price and lowest price for each day for stock i; share price, which is the natural log of the average trading price for stock i on day t; market value, which is the natural log of market value for each stock for each day. $Dummy_{i,t}$ is a dummy variable, with value of 0 if before the event or 1 otherwise. $\varepsilon_{i,t}$ is an error term, assumed to follow classical rules. Following the methodology of Fama and French (1992), the coefficients appearing in the table are averaged across the sample firms and the values in parentheses are the corresponding t values. Panel A and Panel B give the results for large

firms and small firms, respectively. Values that are significantly different from 0 are denoted by *, ** and *** indicating significance at 10%, 5%, and 1% levels, respectively.

7.0 Conclusion

Using intraday data from the TSEC, this study investigates the impact of additional disclosure from limit-order books on the trading information and price discovery. The major findings, obtained from a comparison before and after the event, are summarized below. First, with the exception of the last trading period for large firms, there is no significant change in the WPC or the WPCT. Second, there is an increase in the private information ratio, but a decrease in the public information ratio for all sized firms. On the whole, the study supports the viewpoint that transparency has a positive impact on stock market. That is to say the transparency event is beneficial to market fairness, efficient market and price discovery.

References

Admati, Anat R. & Pfleiderer, Paul. (1991). Sunshine trading and financial market equibrium. *Review of Financial Study* 4, pp.443-481.

Bange, M. M. (2000). Do the portfolios of small investors reflect positive feedback trading? Journal of Financial and Quantitative Analysis 35, pp.239–55.

Barclay, M. J. & Hendershott, T. (2003). Price discovery and trading after hours. Review of Financial Studies 16, pp.1041-1073.

Baruch, S. (2005). Who benefits from an open limit-order book? Journal of Business

78, pp.1267-1306.

Bloomfield, R. & O'Hara, M. (1999). Market transparency: Who wins and who loses? *Review of Financial Studies* 12, pp.5-35.

Board, J. & Sutcliffe, C. (1996). The proof of the pudding: the effects of increased trade transparency in the London Stock Exchange. Unpublished working paper, London School of Economics, London.

Boehmer, E. Saar, G. & Yu, L. (2005). Lifting the veil: an analysis of pre-trade transparency at the NYSE. *Journal of Finance* 60, pp.783-815.

Boulatov, Alex. & Thomas, George J. (2013). Hidden and displayed liquidity in securities markets with informed liquidity providers. *Review of Financial Studies* 26, pp.2095-2137.

Chiou w. p. & Serrano, A. (2024). Transparency in the equity market: evidence from a natural experiment. International Review of Economics and Finance 89, pp.1348-1368

Cao, C. Hansch, O. & Wang, X. (2009). The information content of an open limit-order book. *Journal of Futures Markets* 29, pp.16-41.

Degryse, H. De Jong, F. & Kervel, V. (2014). The impact of dark trading and visible fragmentation on market quality, Review of Finance, 19(4), 1587–1622.

Fama, E. F. (1970). Efficient capital markets: a review of theory and empirical work. Journal of Finance 25, pp.383-417.

Flood, M. Huisman, R. Koedijk, K. Mahieu, R. & Roell, A. (1997b). Post-Trade Transparency in Multiple Dealer Financial Markets. Working paper, Limburg Institute of Financial Economics, University of Limburg.

Flood, M. Huisman, R. Koedijk, K. & Mahieu, R. (1999). Quote disclosure and price discovery in multiple dealer financial markets. Review of Financial Studies 12, pp.37-59.

French, K., & Roll, R. (1986). Stock return variance: The arrival of information and the reaction of trades. *Journal of Financial Economics* 17, pp.5-26.

Frutos, M. A'ngeles de, and C. Manzano, 2005, Trade disclosure and price dispersion, *Journal of Financial Markets* 8, pp.183-216.

Frutos, M. de A'ngeles & Manzano, C. (2014). Market transparency, market quality, and sunshine trading. *Journal of Financial Markets* 17, pp.174-198.

Gemmill, G., 1996, Transparency and liquidity: a study of block transactions in the London Stock Exchange. Journal of Finance 51, 1765-1790.

Han, B. & Yang, L. (2013). Social networks, information acquisition, and asset prices. *Management Science* 59, pp.1444-1457.

Hasbrouck, J. (1991b). The summary informativeness of stock trades: An econometric analysis. *Review of Financial Studies* 4, pp.571-595.

Hasbrouck, J. (1995). One security, many markets: determining the contribution to price discovery. *Journal of Finance* 50, pp.1175-1199.

Hendershott, T. Jones, Charles & Menkveld, Albert J. (2011). Does algorithmic trading improve liquidity? *Journal of Finance* 66, pp.1-32.

Hsieh, Tsung-Yu.(2015). Information disclosure and price manipulation during the pre-closing session: evidence from an order-driven market. *Applied Economics* 47, pp.4670-4684.

Lin, Chiou-Fa, & Chiao, Cheng-Huei. (2020). Widening price limit effects: Evidence from an emerging stock market. Applied Economics 52, pp.1476-1486.

Lin, Chiou-Fa, Lai, Ya-Wen & Tang, Mei-Ling. (2016). Is the incremental transparency necessary? *Investment Analysts Journal* 45, pp.95-109.

Madhavan, A. (1995). Consolidation, fragmentation, and the disclosure of trading information. The Review of Financial Studies 8, pp.579-603.

Madhavan, A. (1996). Security prices and market transparency. Journal of financial intermediation 5, pp.255-283.

Madhavan, A. Porter, D. & Weaver, Daniel G. (2005). Should securities markets be transparent? Journal of Financial Markets 8, pp. 265-287.

O'Hara, M. (2003). Liquidity and price discovery. *Journal of Finance* 58, pp.1335–54.

Pagano, M. & Roell, A. (1996). Transparency and liquidity: a comparison of auction and dealer markets with informed trading, *Journal of Finance* 51, pp.579-611.

Paul, J.M. (1993). Crowding out and the informativeness of security prices. *Journal of Finance* 48, pp.1475-1496.

Porter, David C. & Weaver, Daniel G. (1998). Post-trade transparency on Nasdaq's

national market system. *Journal of Financial Economics* 50, pp.231-252.

Riordan, Ryan, & Storkenmaier, A. (2012). Latency, liquidity and price discovery. Journal of Financial Markets 15, pp.416-437.

Sias, R. Starks, L. T. & Titman, S. (2006). Changes in institutional ownership and stock returns: assessment and methodology. *The Journal of Business* 79, pp.2869–910.

Tang, Ya. (2014). Information disclosure and price discovery. *Journal of Financial Markets* 19, pp.39-61.