

PRE-CLOSE TRANSPARENCY AND PRICE EFFICIENCY AT MARKET CLOSING: EVIDENCE FROM THE TAIWAN STOCK EXCHANGE

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ABSTRACT

This paper examines the impact of increased pre-close transparency on the effectiveness of stock closing call. On January 1, 2003, the Taiwan Stock Exchange increases pre-close transparency by disclosing the best five bid and ask prices and related unexecuted orders before market closing. At the same time, the Taiwan Stock Exchange does not disseminate any information about the limit-order book during the five-minute closing call period. This institutional change presents an opportunity to analyze how an increase in pre-close transparency affects informed trading and price efficiency near market closing. Empirical results show that an increase in pre-close transparency enhances the price efficiency of stock closing call, implying that informed traders will increase their trading during stock closing call following pre-close transparency increases.

JEL: G14, G15, G18

KEYWORDS: Transparency, Closing call, Price efficiency, Taiwan Stock Exchange

INTRODUCITON

This paper investigates whether an increase in pre-close transparency alters the effectiveness of stock closing call. Previous studies have examined the impact of stock closing call on price efficiency at market closing, and conclude that the introduction of stock closing call could enhance market quality (e.g., Pagano and Schwartz, 2003; Huang and Tsai, 2008). On the other hand, prior studies have examined the effects of transparency on trading behavior of informed traders and the results to date are far from conclusive. One argues that informed traders trade more accurately in a transparent environment since they could tap the liquidity offered by the limit-order book more efficiently (e.g., Madhavan et al., 2005). The other suggests that informed traders prefer markets with less transparency to avoid revealing their private information (e.g., Chowdhry and Nanda, 1991; Comerton-Forde and Rydge, 2006). While there is no consensus in the literature on the influence of transparency on trading behavior of informed traders, this paper provides additional evidence regarding this issue by examining the impact of pre-close transparency on the efficacy of stock closing call.

Starting from January 1, 2003, the Taiwan Stock Exchange (TWSE) enhances transparency by disclosing the best five bid and ask prices and related unexecuted orders in the trading period between 9:00 and 13:25. At the same time, the TWSE disseminates no information regarding the limit-order book during the five-minute closing call period surrounding this institutional change. Thus, this unique design provides an opportunity to examine how an increase in pre-close transparency affects informed trading near market closing and then price efficiency of stock closing call.

The empirical results indicate that the quotation information, including bid-ask spreads and market depth, do not change significantly near market closing following pre-close transparency increases. However, this change in pre-close transparency results in larger trading volume, and then induces higher adjusted R-square of market model and less absolute return autocorrelation at market closing. The findings provide evidence that the increase in pre-close transparency could enhance the price efficiency of stock closing call. Thus, this paper conclude that, after pre-close transparency increases, informed traders will increase

their trading during stock closing call when disclosing no limit-order book information at that time. The findings support Chowdhry and Nanda (1991) that informed traders prefer to trade in an opaque environment.

The remainder of this study is organized as follows. Section 2 provides a brief literature review. Section 3 develops the research hypotheses. Section 4 describes how the sample is chosen and the methodology used in this paper. Empirical results are presented in section 5. Section 6 concludes the paper.

LITERATURE REVIEW

Previous research examines whether an introduction of stock closing call leads to an improvement in market quality. Most of previous literature concludes that stock closing call could enhance market quality. Hillion and Suominen (1998) examine the closing price behavior of the CAC 40 stocks on the Paris Bourse, and find that there exists high price volatility and bid-ask spreads near market closing due to price manipulation. Hillion and Suominen (1998) thus prompt the Paris Bourse to implement the closing call auction. Hillion and Suominen (2004) then develop a theoretical model of closing price manipulation and suggest that the call auction is the optimal closing mechanism because it could reduce price manipulation. Similarly, Pagano and Schwartz (2003) examine the impact of the introduction of stock closing call auction on market quality of Paris Bourse. Pagano and Schwartz (2003) find that the introduction of stock closing call reduces transaction costs and sharpens price discovery at the end of the day. In addition, Pagano and Schwartz (2005) examine the impact of stock closing call on price determination on the NASDAQ. Pagano and Schwartz (2005) find that stock closing call also improve the market quality for the stocks listed in the Russell 2000.

Moreover, the introduction of stock closing call also improves the market quality in the Asia-Pacific stock markets. Comerton-Forde et al. (2007) examine whether the Singapore Exchange introduces opening and closing call auctions affect stock market quality, and find that the introduction of call auctions enhances the market quality at both market opening and closing. Huang and Tsai (2008) also examine the effects of the introduction of stock closing call on the TWSE. Huang and Tsai (2008) find that stock closing call could reduce the price volatility at market closing and enhances the market efficiency by reducing noise in stock closing prices.

On the other hand, the effects of transparency have attracted considerable attention from practitioners, researchers, and policymakers. Transparency is defined as the availability of information regarding participants' buy and sell orders before executed on the limit-order book (O'Hara, 1995). Prior studies assess the change in market quality associated with an increase in transparency; however, there is no consensus in the literature on whether increased transparency results in an improvement in market quality. Baruch (2005) constructs a theoretical model infer how an increase in transparency affects market quality. Baruch (2005) concludes that increased transparency reduces the bid-ask spread and increases the informational efficiency of stock price. Also, Boehmer et al. (2005) investigate the impact of the introduction of the OpenBook that provides limit-order book information to traders off the exchange floor on the NYSE. Boehmer et al. (2005) indicate that greater transparency leads to higher market liquidity and greater price efficiency.

Examining a reduction in the transparency of the limit-order book on the Island ECN, Hendershott and Jones (2005) find that the dominant market for the three most active ETF's decreases market quality following transparency decreases, and the market quality then improves when Island later redisplay its orders. Besides, Chung and Chuwonganant (2009) examine the influence of transparency on market quality using data surrounding the introduction of the SuperMontage which is a fully integrated order display and execution system for NASDAQ-listed stocks. Chung and Chuwonganant (2009) show that both bid-ask spreads and return volatility decline significantly after the implementation of the

SuperMontage, and conclude that the SuperMontage does improve the market quality on the NASDAQ.

In contrast, Madhavan (1996) study the same question by theoretical model and their viewpoint is different from Baruch (2005). Furthermore, Madhavan et al. (2005) examine such an increase by empirical study to support the theoretical inference of Madhavan (1996). Madhavan et al. (2005) test whether an increase in transparency results in worse market quality after the Toronto Stock Exchange disseminates information about bid and ask depth at the top four price levels in the limit-order book. Madhavan et al. (2005) find that increased transparency results in higher trade execution costs and price volatility.

In summary, previous studies have provided considerable insight into the efficacy of stock closing call. Previous research has also generated interesting findings about the effects of transparency. However, no work has been conducted into the influence of pre-close transparency on the effectiveness of stock closing call when disclosing no limit-order book information at that time. Thus, this paper attempts to bridge this gap.

HYPOTHESES

As suggested by Zhao and Chung (2006), informed traders buy when prices are below the estimates of fundamental value and sell when prices are above the estimates; hence, their trading could move prices to the estimates of fundamental value. Since informed traders could estimate values accurately, their trading then makes prices more informative and efficient. Based on Zhao and Chung (2006), two competing hypotheses have been offered to explain the impact of pre-close transparency on informed trading and then price efficiency near market closing.

On the one hand, an increase in pre-close transparency may result in lower price efficiency at market closing. Madhavan et al. (2005) states that, if transparency increases informed traders' expected profits by allowing them to tap the liquidity offered by the limit-order book more efficiently than in an opaque environment, then informed traders trade more accurately in a transparent environment, speeding up the process of price discovery. Since the TWSE increases pre-close transparency but disseminates no limit-order book information during stock closing call period, an increase of pre-close transparency should decrease price efficiency at market closing.

On the other hand, Chowdhry and Nanda (1991) suggest that informed traders prefer markets with less transparency to avoid revealing their private information, implying informed traders prefer to trade in an opaque environment. Also, Comerton-Forde and Rydge (2006) and Grossman and Miller (1988) indicate that informed traders prefer to trade in an opaque market where they could retain their informational advantage. Since Zhao and Chung (2006) argue that the trading of informed traders facilitates price efficiency, this paper predicts that the opacity of stock closing call should attract more informed trading after pre-close transparency increases, and then results in higher price efficiency of stock closing call.

DATA AND MATHODOLOGY

Before the end of 2002, only the unexecuted orders of the limit-order book at the best bid and ask prices are disclosed. Due to the belief that increased transparency leads to a fairer and more efficient market, the TWSE enhances pre-close transparency by disclosing the best five bid and ask prices and related unexecuted orders on January 1, 2003. Nevertheless, the TWSE disseminates no information about the limit-order book during the five-minute closing call period at the same time. This makes the limit-order book at market closing a black box for traders. The price efficiency of stock closing call after pre-close transparency increases is therefore valuable to investigate.

Thus, this paper utilizes intraday data to analyze the effects of an increase in pre-close transparency on the effectiveness of stock closing call in the Taiwan stock market. The data is taken from the Taiwan Economic Journal (TEJ) database, which provides the price and volume of executed orders and quotation information of limit-order book for each stock

The sample period is divided into two sub-periods, namely, before and after the increase of pre-close transparency. *Before*, from October 8, 2002 to December 31, 2002 (a total of 60 trading days), represents only the unexecuted orders at the best bid and ask prices are disclosed. *After*, from April 1, 2003 to June 25, 2003 (a total of 60 trading days), represents the unexecuted orders at the best five bid and ask prices are disclosed. Due to the data availability on the TEJ database, the *After* period in this study is starting from April 1, 2003. Moreover, this paper selects sample stocks according to the following criteria: (1) the stocks are common stocks on the TWSE; (2) the stocks are traded both before and after pre-close transparency increases; and (3) the stocks are the top 50 largest firms in the testing sample. Then, this paper gathers data with each five-minute interval during the last half-hour of the selected days.

To evaluate the impact of increased pre-close transparency on the effectiveness of stock closing call, this paper begins by calculating relative quoted spread and relative effective spread in each five-minute interval during 13:00-13:30. Adopting relative proxies could control for differences across stocks and time. Relative quoted spread and relative effective spread are the two standard measures of transaction costs. Relative quoted spread is estimated as the difference between the best ask price and bid price and then divided by the midpoint of the bid and ask price. In the interest of completeness, this paper also reports relative effective spread for each stock, measured as twice the difference between the transaction price and the midpoint of the bid and ask price and then divided by the midpoint of the bid and ask price.

Similar to calculating spreads, market depth is measured by relative bid depth and relative ask depth. Relative bid depth for each stock is the quoted volume at the highest bid price in each five-minute interval divided by the total daily trading volume. Relative ask depth for each stock is the quoted volume at the lowest ask price in each five-minute interval divided by the total daily trading volume.

This paper then utilizes relative trading volume to measure the impact of increased pre-close transparency on trading activities near market closing. Both trading volume measured by lots and trading volume measured by dollar are used in this study. The change of relative trading activities near market closing surrounding pre-close transparency increases could provide some evidence regarding the trading behavior of informed traders. Relative trading volume is the trading volume in each five-minute interval relative to the total trading volume for the entire day.

Pagano and Schwartz (2003) propose a test of price efficiency via examining the price synchronicity across a set of stocks. An increase in the adjusted R-squares of market model would signal greater synchronicity in stock prices, thereby improving price efficiency. Thus, a comparison of the adjusted R-squares of market model at market closing surrounding pre-close transparency increases provides evidence regarding the impact of pre-close transparency on price efficiency of stock closing call.

The market model is estimated for stock return in each five-minute interval during 13:00-13:30. The Taiwan Weighted Stock Index (TWSI) is used as a proxy for the market portfolio. Therefore, the market model could be estimated as follows:

$$R_{itd} = b_{it0} + b_{it1}R_{mtd} + e_{itd} \quad (1)$$

where R_{itd} is the return of stock i in time interval t for day d , R_{mtd} is the corresponding market return, e_{itd} is a random error term, and b_{it0} and b_{it1} are coefficients to be estimated.

Return autocorrelation is another measure of price efficiency. Boehmer et al. (2005) indicate that a more efficient price process would be closer to a random walk and therefore exhibit less return autocorrelation (both positive and negative). Thus, this paper estimates absolute value of return autocorrelation rolled on a five-minute interval from 13:00 to 13:30 as follow:

$$| \text{AutoCorr}_{it} | = | \text{Corr}(R_{i,t-1,d}, R_{itd}) | \tag{2}$$

where AutoCorr_{it} is the return autocorrelation of stock i in time interval t .

RESULTS

Table 1 and Table 2 present the preliminary analysis regarding the effects of the increase in pre-close transparency on quotation information near market closing. Table 1 shows the differences of bid-ask spreads during 13:00-13:30 surrounding pre-close transparency increases. Panel A of Table 1 indicate that the relative quoted spreads near market closing change insignificantly at the 5% level following pre-close transparency increases. Panel B of Table 1 also indicates that the change of the relative effective spreads nearing market closing are not significant after pre-close transparency increases.

Table 1: Bid-ask Spread Near Market Closing before and bfter Pre-Close Transparency Increases

Time	Before	After	$\Delta \text{Diff.}$ = $\text{Diff.}_{\text{After}} - \text{Diff.}_{\text{Before}}$
<i>Panel A: Relative Quoted Spreads</i>			
(1) 13:00-13:05	0.0043	0.0043	
(2) 13:05-13:10	0.0043	0.0042	
(3) 13:10-13:15	0.0044	0.0043	
(4) 13:15-13:20	0.0044	0.0043	
(5) 13:20-13:25	0.0044	0.0043	
(6) 13:25-13:30	0.0045	0.0045	
Diff.	0.0001*	0.0001**	0.0000
= (6) - (5)	(2.39)	(3.87)	(0.53)
<i>Panel B: Relative Effective Spreads</i>			
(1) 13:00-13:05	0.0043	0.0042	
(2) 13:05-13:10	0.0043	0.0042	
(3) 13:10-13:15	0.0043	0.0042	
(4) 13:15-13:20	0.0043	0.0042	
(5) 13:20-13:25	0.0043	0.0043	
(6) 13:25-13:30	0.0045	0.0045	
Diff.	0.0002**	0.0002**	0.0000
= (6) - (5)	(3.01)	(4.11)	(0.07)

*This table presents the bid-ask spread near market closing before and after pre-close transparency increases. Before, from October 8, 2002 to December 31, 2002 (a total of 60 trading days), represents only the unexecuted orders at the best bid and ask prices are disclosed. After, from April 1, 2003 to June 25, 2003 (a total of 60 trading days), represents the unexecuted orders at the best five bid and ask prices are disclosed. Numbers in parentheses denote t-statistics. *Significant at the 5% level. **Significant at the 1% level.*

Table 2 shows similar results in the differences of relative bid depth and relative ask depth. Panel A or Panel B of Table 2 indicate that the relative bid depth and relative ask depth near market closing do not change significantly surrounding pre-close transparency increases. Combing the results of bid-ask spreads and market depth, we find that increased pre-close transparency has no significant impact on the quotation information of limit-order book during the closing call period.

Trading Activities

This paper now examines the relative trading volume near market closing before and after pre-close transparency increases. Panel A of Table 3 shows that, from 13:20-13:25 to 13:25-13:30, the relative trading volume measured by lots significantly increases from 0.0332 to 0.0426 with the t-value of 5.90 in the *before* period and increases from 0.0311 to 0.0507 with the t-value of 11.11 in the *after* period. Furthermore, after pre-close transparency increases, the difference of relative trading volume measured by lots at market closing significantly increases from 0.0094 to 0.0196 with the t-value of 5.87. Similarly, Panel B of Table 3 shows that, after pre-close transparency increases, the difference of relative trading volume measured by dollar near market closing significantly increases from 0.0093 to 0.0196 with the t-value of 5.89. The results suggest that, following pre-close transparency increases, there exists a significant increase in trading activities during the closing call period.

Table 2: Market Depth Near Market Closing Before and After Pre-Close Transparency Increases

Time	Before	After	Δ Diff. = Diff. _{After} - Diff. _{Before}
<i>Panel A: Relative Bid Depth</i>			
(1) 13:00-13:05	0.0379	0.0580	
(2) 13:05-13:10	0.0346	0.0582	
(3) 13:10-13:15	0.0369	0.0598	
(4) 13:15-13:20	0.0387	0.0523	
(5) 13:20-13:25	0.0381	0.0555	
(6) 13:25-13:30	0.0364	0.0616	
Diff.	-0.0017	0.0061*	0.0078
= (6) - (5)	(-0.51)	(2.36)	(1.83)
<i>Panel B: Relative Ask Depth</i>			
(1) 13:00-13:05	0.0211	0.0564	
(2) 13:05-13:10	0.0204	0.0546	
(3) 13:10-13:15	0.0201	0.0544	
(4) 13:15-13:20	0.0194	0.0540	
(5) 13:20-13:25	0.0194	0.0537	
(6) 13:25-13:30	0.0224	0.0532	
Diff.	0.0030**	-0.0005	-0.0035
= (6) - (5)	(4.20)	(-0.23)	(-1.43)

*This table presents the market depth near market closing before and after pre-close transparency increases. Before, from October 8, 2002 to December 31, 2002 (a total of 60 trading days), represents only the unexecuted orders at the best bid and ask prices are disclosed. After, from April 1, 2003 to June 25, 2003 (a total of 60 trading days), represents the unexecuted orders at the best five bid and ask prices are disclosed. Numbers in parentheses denote t-statistics. *Significant at the 5% level. **Significant at the 1% level.*

Price efficiency

In order to test the price efficiency of stock closing call, this paper then examines the adjusted R-squares of market model and absolute return autocorrelations near market closing before and after pre-close transparency increases. Panel A of Table 4 presents the adjusted R-squares of market model during 13:00-13:30 surrounding the increase of pre-close transparency. The results indicate a significant improvement in price discovery at market closing after pre-close transparency increases. In the *before* period, the adjusted R-square reduces significantly from 0.1182 in 13:20-13:25 to 0.0620 in 13:25-13:30 with the t-value of -4.02. In the *after* period, the adjusted R-square increase significantly from 0.0477 in 13:20-13:25 to 0.2064 in 13:25-13:30 with the t-value of 6.56. As comparing the difference of the adjusted R-square between 13:20-13:25 and 13:25-13:30, this paper finds that the difference of the adjusted R-square increases significantly from -0.0562 to 0.1587 with the t-value of 9.53 following transparency increases. In particular, the smallest adjusted R-square in the *before* period occurs in the time interval 13:25-13:30, but the largest adjusted R-square in the *after* period occurs in the time interval

13:25-13:30. Thus, the evidence indicates that price efficiency enhances significantly during the closing call period after pre-close transparency increases, because a tighter fit between the individual stock returns and market returns at market closing in the *after* period.

Table 3: Trading Volume Near Market Closing Before and after Pre-Close Transparency Increases

Time	Before	After	$\Delta\text{Diff.}$ = Diff. _{After} - Diff. _{Before}
<i>Panel A: Relative Trading Volume Measured by Lots</i>			
(1) 13:00-13:05	0.0186	0.0169	
(2) 13:05-13:10	0.0189	0.0189	
(3) 13:10-13:15	0.0203	0.0208	
(4) 13:15-13:20	0.0223	0.0226	
(5) 13:20-13:25	0.0332	0.0311	
(6) 13:25-13:30	0.0426	0.0507	
Diff.	0.0094**	0.0196**	0.0102**
= (6) - (5)	(5.90)	(11.11)	(5.87)
<i>Panel B: Relative Trading Value Measured by Dollar</i>			
(1) 13:00-13:05	0.0186	0.0169	
(2) 13:05-13:10	0.0188	0.0189	
(3) 13:10-13:15	0.0203	0.0208	
(4) 13:15-13:20	0.0222	0.0226	
(5) 13:20-13:25	0.0332	0.0311	
(6) 13:25-13:30	0.0425	0.0507	
Diff.	0.0093**	0.0196**	0.0103**
= (6) - (5)	(5.87)	(11.11)	(5.89)

*This table presents the trading volume near market closing before and after pre-close transparency increases. Before, from October 8, 2002 to December 31, 2002 (a total of 60 trading days), represents only the unexecuted orders at the best bid and ask prices are disclosed. After, from April 1, 2003 to June 25, 2003 (a total of 60 trading days), represents the unexecuted orders at the best five bid and ask prices are disclosed. Numbers in parentheses denote t-statistics. *Significant at the 5% level. **Significant at the 1% level.*

Panel B of Table 4 presents the absolute return autocorrelations near market closing before and after pre-close transparency increases. In a more efficient market mechanism, there exists less return autocorrelation, either positive or negative. Thus, absolute return autocorrelations provides another method to analyze price efficiency. Panel B of Table 4 shows that, in the *after* period, the absolute return autocorrelation becomes smaller significantly from 0.2735 in 13:20-13:25 to the lowest value, 0.1888, in 13:25-13:30 with the t-value of -3.70. After pre-close transparency increases, the difference of absolute return autocorrelation between 13:20-13:25 and 13:25-13:30 significantly decreases from 0.0086 to -0.0847 with the t-value of -3.52. The findings of absolute return autocorrelations indicate that the price efficiency during the closing call period indeed improve after increased pre-close transparency.

Regression Analysis

Table 5 presents the regression analysis of trading activities and price efficiency at market closing surrounding pre-close transparency increases. The following regression model is used in this study to access the effects of increased pre-close transparency on the effectiveness of stock closing call:

$$DV_i = \beta_0 + \beta_1 \text{Dummy}_i + \beta_2 (1/\text{Price})_i + \beta_3 \text{Ln}(\text{Size})_i + \varepsilon_i \quad (3)$$

where DV_i is each dependent variable for firm i , including the differences of relative trading volume, adjusted R-square of market model, and absolute return autocorrelation between 13:20-13:25 and 13:25-13:30. The Dummy_i is equal to 1 if the data is in the *After* period and is equal to 0 if the data is in the *Before* period. The inverse of price $(1/\text{Price})_i$ and the natural logarithm of market capitalization

$\ln(\text{Size})_i$ are used to control for heteroskedasticity caused by variation between different price levels as well as firm size. ε_i is the error term.

Table 4: Price Efficiency Near Market Closing Before and After Pre-Close Transparency Increases

Time	Before	After	$\Delta\text{Diff.}$ = $\text{Diff.}_{\text{After}} - \text{Diff.}_{\text{Before}}$
<i>Panel A: Adjusted R-square of Market Model</i>			
(1) 13:00-13:05	0.3250	0.1126	
(2) 13:05-13:10	0.2042	0.1526	
(3) 13:10-13:15	0.2024	0.1117	
(4) 13:15-13:20	0.1653	0.1185	
(5) 13:20-13:25	0.1182	0.0477	
(6) 13:25-13:30	0.0620	0.2064	
Diff.	-0.0562**	0.1587**	0.2149**
= (6) - (5)	(-4.02)	(6.56)	(9.53)
<i>Panel B: Absolute Return Autocorrelation</i>			
(1) 13:00-13:05	0.1878	0.2758	
(2) 13:05-13:10	0.2139	0.2163	
(3) 13:10-13:15	0.2129	0.2238	
(4) 13:15-13:20	0.2083	0.2765	
(5) 13:20-13:25	0.1930	0.2735	
(6) 13:25-13:30	0.2016	0.1888	
Diff.	0.0086	-0.0847**	-0.0933**
= (6) - (5)	(0.39)	(-3.70)	(-3.52)

*This table presents the adjusted R-squares of market model and absolute return autocorrelations near market closing before and after pre-close transparency increases. Before, from October 8, 2002 to December 31, 2002 (a total of 60 trading days), represents only the unexecuted orders at the best bid and ask prices are disclosed. From April 1, 2003 to June 25, 2003 (a total of 60 trading days), represents the unexecuted orders at the best five bid and ask prices are disclosed. Numbers in parentheses denote t-statistics. *Significant at the 5% level. **Significant at the 1% level.*

Table 5 shows that, even controlling firm characteristics, the relative trading volume measured by lots, relative trading volume measured by dollar, adjusted R-square of market model, and absolute return autocorrelation all change significantly at market closing after pre-close transparency increases. From 13:20-13:25 to 13:25-13:30, the relative trading volume measured by lots, relative trading volume measured by dollar, and adjusted R-square of market model significantly increase, but the absolute return autocorrelation decreases significantly. The findings of regression analysis also reveal that, after pre-close transparency increases, informed traders will increase their trading during the closing call period and then result in higher efficiency of closing price.

CONCLUSION

This paper analyzes the impact of increased pre-close transparency on the effectiveness of stock closing call. On January 1, 2003, the TWSE increase pre-close transparency by disclosing the best five bid and ask prices and related unexecuted orders. However, the TWSE disseminates no information about the limit-order book during the five-minute closing call period. Hence, this institutional change provides an opportunity to examine how an increase in pre-close transparency affects the price efficiency of stock closing call.

According to Madhavan et al. (2005) and Chowdhry and Nanda (1991), this paper proposes two competing hypotheses to explain how an increase in pre-close transparency affect trading behavior of informed traders and then price efficiency during stock closing call. The empirical results show that, following pre-close transparency increases, the trading activities and price efficiency at market closing enhances on the TWSE. The relative trading volume and adjusted R-square of market model increase

significantly at market closing after pre-close transparency increases; furthermore, the absolute return autocorrelation becomes smaller at the end of the day. The findings suggest that increased pre-close transparency could enhance the price efficiency of stock closing call when disseminating no information about the limit-order book at that time. Thus, this paper concludes that informed traders will increase their trading during stock closing call following pre-close transparency increases, and this is consistent with the prediction of Chowdhry and Nanda (1991) that informed traders prefer to trade in an opaque environment.

This paper examines the relationship between pre-close transparency and price efficiency at market closing in a comprehensive way. However, due to the limited availability of intraday data, this paper does not have access to information on each trader's type (e.g., individual investors versus institutional investors) which could provide more detailed regarding the relationship of pre-close transparency and informational efficiency at market closing. How individual and institutional investors trade at marketing closing surrounding pre-close transparency increases is an interesting topic for future research.

Table 5: Regression Analysis of Trading Activities and Price Efficiency at Market Closing Surrounding Pre-Close Transparency Increases

Dependent Variable	Constant	Dummy	1/Price	Ln(Size)	R ²
<i>Panel A: Trading activities</i>					
Relative Trading Volume Measured by Lots	-0.0246 (-1.30)	0.0101** (4.30)	0.0169 (0.35)	0.0030 (1.85)	0.19
Relative Trading Volume Measured by Dollar	-0.0247 (-1.30)	0.0102** (4.32)	0.0169 (0.35)	0.0030 (1.85)	0.19
<i>Panel B: Price efficiency</i>					
Adjusted R-square of Market Model	-0.5433* (-2.48)	0.2118** (7.77)	1.3020* (2.32)	0.0385* (2.08)	0.42
Absolute Return Autocorrelation	0.0303 (0.12)	-0.0935** (-2.92)	0.1604 (0.24)	-0.0025 (-0.12)	0.08

*This table shows the regression analysis at market closing surrounding pre-close transparency increases. The dependent variables are the differences of relative trading volume, adjusted R-square of market model, and absolute return autocorrelation between 13:20-13:25 and 13:25-13:30. The Dummy is equal to 1 if the data is in the After period and is equal to 0 if the data is in the Before period. Before, from October 8, 2002 to December 31, 2002, represents only the unexecuted orders at the best bid and ask prices are disclosed. After, from April 1, 2003 to June 25, 2003, represents the unexecuted orders at the best five bid and ask prices are disclosed. Furthermore, the inverse of price 1/Price and the natural logarithm of market capitalization Ln(Size) are used to control for heteroskedasticity caused by variation between price levels as well as firm size. Numbers in parentheses denote t-statistics. *Significant at the 5% level. **Significant at the 1% level.*

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