Order Submission Decisions and Market Performance under Different Trading Mechanisms

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ABSTRACT

This study empirically investigates the relationship among trading arrangements, order submission decisions, and market performance. We analyze investors' placement decisions and their impact on market volatility as well as liquidity under different trading frequencies. Extending beyond the scope of microstructure theoretical papers, this study focuses on whether transaction uncertainty and asymmetric information affect traders' order placement strategies. The findings indicate that traders tend to place higher (lower) reservation buy (sell) prices to cope with transaction uncertainty under a less continuous-like market with more severe problem of asymmetric information. In particular, small traders place higher reservation prices in a less continuous market than in a more continuous-like market; this may help absorb incoming orders from the counterpart side, and thus, the market becomes more liquid and less volatile.

1. INTRODUCTION

The literature on rational expectations suggests that prices aggregate information efficiently when trading is organized as an auction with large numbers of traders. However, most of the financial markets around the world are not organized as auction markets; instead, they conduct a continuous market with or without a dealer system. Moreover, recent theoretical and empirical researches on market microstructure document that institutional arrangements have important effects on the formation of prices. Therefore, it is important for policy makers to understand how trading mechanisms affect stock price behavior.

A crucial role of trading arrangements is to transform the demands of investors into realized trades. Trading strategy is an important decision that investors need to make in addition to investment decision. Traders must decide whether to place market orders or limit orders, and what should be the quoted prices in the case of limit orders. On the one hand, traders want their orders to be executed, and on the other hand, they do not want to buy too high or sell too low. An important feature of the price formation is that it relies not only on trading mechanisms, but also upon order submission strategies.

Although order submission decision is of paramount importance, the issue of order placement on price behavior under different trading designs has received little attention in empirical literature. The relative performance of continuous markets and call markets has long been an interesting issue. Kyle [7], Pagano and Roell [11], Madhavan [10] and Schnitzlein [12] examined the issue from a theoretical aspect. These studies suggested that call market enhance market performance under asymmetric information despite the utilization of very different approaches to model the formidably complicated interactions in order placement and alternative trading designs.

Though theoretical works have incorporated order placement decisions into the comparisons of institutional arrangements, most of empirical works focused only on the impact that continuous and call markets have on market performance, thereby neglecting the role of trading strategies. For example, Amihud and Mendelson [2] compared the call system with the continuous market using the open-to-open

returns and close-to-close returns of the New York Stock Exchange. They found that open-to-open returns have higher volatility than close-to-close returns. Later in 1991, they mitigated the overnight non-trading problems using data from the Tokyo Stock Exchange, and found that in terms of volatility and efficiency, a call market is not inferior to a continuous market. Lauterbach and Ungar [8] investigated the impact of the transfer of 29 stocks in the Tel-Aviv Stock Exchange from a single daily auction to a more continuous-like trading system. They found that under a more continuous-like system, the standard deviation of daily market model residuals decreased, and trading volume increased, suggesting that a continuous market contributes to price accuracy and better suits traders' preferences.

The conclusions reached by previous empirical studies have been inconsistent. This could be due to the fact that mostly these studies were joint tests of the impact of trading mechanisms and trading recession. As Handa and Schwartz [5] state, an investor's decision to demand immediacy or to trade patiently depends on the price of immediate liquidity. In turn, the price of immediate liquidity depends on the architecture of the trading system. However, previous studies do not explicitly address how investors' trading strategy would affect market performance under alternative trading arrangements. The lack of coverage on this importance topic is probably due to the unavailability of order flow data.

The primary purpose of this paper is to study the behavior of traders under alternative trading arrangements, and the impact of order placement on market performance. We compare the limit order strategies for different types of traders under alternative trading frequencies. This study extends the works of Cohen, et al. [3], Ho, et al. [6], Schwartz [13], Handa and Schwartz [5] and Ahn, et al. [1], all these studies developed models of limit order trading. Relevant empirical studies have examined the pair-wise relationship between trading arrangements and market performance, and between order submission decisions and market performance. However, to the author's best knowledge, this study is the first empirical paper to document the relationship among trading arrangements, order submission decisions, and market performance.

In this study, we expand beyond the scope of the relevant theoretical works in three ways. First, we empirically examine order

placement strategies under call and more continuous-like market designs. According to Ho, et al. [6], traders will encounter transaction uncertainties in the call market method; consequently, order submission decisions in a continuous market may differ from those made in a call market. Consistent with Ho, et al. [6] model, our results show that investors place higher (lower) buy (sell) reservation prices to deal with transaction uncertainty under a less continuous-like market design.

Second, along the line of Kyle [7], Pagano and Roell [11], Madhavan [10] and Schnitzlein [12], this study investigates the relation between information asymmetry and traders' behaviors. In particular, we examine the values of reservation prices for different types of traders (small versus big traders) and different sizes of firms, whereas, order size and firm size are proxies for asymmetric information. Our results indicate that (1) small traders place higher reservation prices to cope with transaction uncertainty in a less continuous-like market than in a more continuous-like market. (2) reservation prices of small traders are higher than those of big traders. (3) traders place higher reservation prices when trading in a small firm than in a large firm.

Third, this paper intends to investigate if the ordering strategies of traders have any impact on market performance. In particular, this study investigates: (1) whether investors who place higher (lower) buy (sell) prices to deal with transaction uncertainties want liquidity and are willing to pay for the price of immediacy; and (2) whether the market volatility and liquidity are affected when traders place high reservation prices. Consistent with the findings of Ahn, et al. [1], the first empirical paper that examine the interaction between limit order trading and price behaviors, our results indicate that the higher reservation price is for small traders, the lesser the market volatility will be. As for market liquidity, our findings support the arguments that the higher (lower) reservation buy (sell) prices placed by small traders has the effect of providing additional depth to the market, and thus partially offsetting the market impact of big traders. While Ahn, et al. [1] suggested that limit-order trading provides liquidity to the market orders, we found that small traders, rather than large traders, provide liquidity to the market.

This study provides an understanding on how the trading process affects the price formation process. In particular, the findings of the study may have this implication for policymakers: trading

arrangements affect the decisions of market participants differently, and thus market performs differently at the tradeoffs of liquidity and volatility. The rest of this paper is organized as follows: Section II describes the testing hypotheses, data and methodology; Section III presents the empirical findings; and Section IV concludes the paper.

II.   HYPOTHESES, DATA AND METHODOLOGY

A. Testing Hypothesis

In the following, we investigate how trading mechanisms affect the investors' decisions and the market performance. Firstly, we address the order placement strategies of investors under different trading frequency. Secondly, we examine if traders' placement under different trading mechanisms is affected by information asymmetry. Finally, we analyze if investors' decisions are related with the market performance as trading mechanism changes. The testing hypotheses are listed below.

Transaction Uncertainty Hypothesis: Due to transaction price uncertainty in a call market with less frequent trading, traders may place higher reservation prices to ensure execution of their orders.

Concerning the characteristics of order placements, Cohen, et al. [3] established an individual investor's order strategy using a compound Poisson process. They concluded that there is a gravitational pull around market quotation prices. That is, when the limit bidding (asking) price remains close to the existing market asking (bidding) price, buyers (sellers) will give up the limit order strategy in favor of a market order strategy to ensure that their order will be executed. Ho, et al. [6] and Schwartz [13] analyzed the order placement strategies of individual investors in a call market. The decision that traders make involves resolving a tradeoff between the desirability of buying at a lower price and the desirability of transacting with certainty. When traders write their orders, all investors face transaction price uncertainty since traders do not know what the transaction price will be when the order is placed, and they cannot react to a specific opportunity cost if a transaction is missed. With transaction price uncertainty, traders will

submit the buy (sell) price that is higher (lower) than the expected clearing price.

The transaction price uncertainty may be larger in a call market than in a continuous market due to the trading design. In a continuous market, an investors' order is executed immediately upon submission; a market order is crossed by a counterpart order, while a limit order is executed at its own price. In contrast, all orders transmitted to a call market are executed at the same market-clearing price. An investor's buy (sell) order is executed if it is placed at a price equal to or higher (lower) than the clearing price. Therefore, traders may face greater transaction price uncertainty under a call market than in a continuous market; accordingly, the order submitted to the continuous market will differ from the order that would have been submitted to a call market. In order to obtain protection from transaction price uncertainty and to ensure the execution of their orders, investors will specify their reservation prices for the order size submitted. We hypothesize that investors would intend to place higher (lower) buy (sell) price in a less continuous-like market.

Asymmetric Information Hypothesis: Uninformed traders will place lower reservation prices than that informed traders place whatever the trading frequency is.

In the model of Handa and Schwartz [5], order submission strategies depend on the investor's beliefs about the probability of his orders executing against an informed or a liquidity trader. In an order driven market, a paucity of limit orders can cause temporary order imbalances that lead to short-run changes in transaction price, whereas an increase in limit order trading decreases short-run volatility. Regarding to the findings of Lee, Lin and Liu [9], small traders are not well informed; accordingly, they may face more transaction uncertainty than big traders. If traders try to avoid the risk of not having an order executed, the reservation prices will be higher for small traders than for big traders. Besides, since the asymmetric information may be more severe for small firms, traders may place higher reservation prices when trading in a small firm than in a large firm. In addition, regarding the relative extent of uncertainty on firm value, small traders may place higher reservation prices than big traders to execute their orders.

Order Impact Hypothesis: The higher (lower) the reservation buy (sell) prices for small traders, the better the market liquidity and the less the market volatility.

Cohen, et al. [3], Ho, et al. [6] and Schwartz [13] have focused on order placement strategies and the price formation process. According to the theoretical work of Ho, et al. [6], order submission decisions in a continuous market may differ from those in a call market; in turn, changes in order strategy may affect market performance. Very few empirical papers investigate order submission decision and price formation processes. One notable exception is Ahn, et al. [1], who studied the dynamic relation between transitory volatility and market depth, and also the effect of transitory volatility on the mix of limit and market orders. Ahn, et al. [1] provide evidence that when there is a paucity of limit orders such that there is an increase in short-term price fluctuations, investors will find it more profitable to place limit orders under a purely order-driven market. The existence of limit order traders provides liquidity to the market, thereby causing a decline in short-term volatility.

B. Data

This study empirically investigates traders' ordering behaviors during reforms in transaction frequency in the Taiwan Stock Exchange (hereinafter TWSE). The TWSE conducts an electronic call market, and the transaction frequencies have been changed twice within a three-month period in 1993. This institutional change provides us with an ideal laboratory to compare market performance and investors' ordering strategy under different trading systems. Moreover, the availability of detailed order flow data allows us to examine the impact of investors' ordering strategy on market performance when transaction frequency changes. Furthermore, the changes of trading interval between two adjacent transactions enable us to exclude the confounding factors due to trading recession before market opening.

The TWSE conducted an electronic call market with two-minute transaction interval from August 2 to September 12, 1993 (hereinafter C_{120}). The transaction interval was changed from two minutes to 90

seconds during the period of September 13 and November 1, 1993 (hereinafter C_{90}), and from 90 seconds to one or two transactions per 90 seconds starting November 2, 1993 (hereinafter C_{90v}). This study compares the changes in traders' ordering strategies and also the market performance under different transaction frequencies (C_{120} v.s. C_{90} and C_{90} v.s. C_{90v}).

Using intraday data around changes in transaction frequencies, this study examines the interim order submission decisions and market performance of a call market during its transition to higher trading frequencies. Sample periods include fifteen trading days before and after changes of call frequencies. We investigated the order flow and transaction data 30 minutes after the market opening, intraday periods, and 30 minutes before the market closing. Order flow and transaction data for 6-minute trading intervals were used to measure order submission decisions and market performance.

C. Definitions of Variables

a. Market performance

This study used four volatility indicators: (1) the standard deviation of six-minute returns, Std(RET); (2) the absolute value of six-minute returns, |RET|; (3) the squared value of the logarithm of the highest price (H) relative to the lowest price (L), i.e, HLP = $[\ln(H/L)]^2$; and (4) the Parkison indicator, $(\ln H - \ln L)^2 / 4\ln2$. To measure market liquidity, we used the Martin Liquidity Index and the Marsh-Rock indicator. The Martin Liquidity Index is equal to the ratio of the squared value of n-minute return (R^2_n) to the trading shares in lots placed by traders within n-minute interval (Vol_n). Marsh-Rock indicator is equal to the ratio of the absolute value of n-minute returns ($|R_n|$) to the number of traders within n-minute interval (N_n). In this study, we set n equal to 6, 12, 18 and 30 minutes. Since the results are similar, we report only the findings of 6 and 18 minutes to conserve space.

b. Reservation prices

This study measures investors' reservation prices (RP) by using the quote price of each trader relative to the prevailing market price. In

particular, the reservation price of buy order (RP_{tji}) equals to $\log(P^*_{tji}/P^c_{t-n,ji})$, where P^*_{tji} is the quote price for any trader at interval t, on day j for stock i; $P^c_{t-n,ji}$ is the clearing price n minutes before the trader made a quote at interval t, on day j for stock i. On the other hand, the reservation price of sell order (RP_{tji}) equals to $\log(P^c_{t-n,ji} / P^*_{tji})$. All of the reservation prices of newly entered orders within each six-minute interval are aggregated and weighted by the order size in lots placed by each trader. We set n equal to 0, 6, 12 and 18 minutes. Since the results with different n are similar, we only present the results with n equal to 6 and 18 minutes. We use RP_6 and RP_{18} to indicate the averages of reservation prices 6-minutes and 18-minutes before each trader places his order for all orders and across 30 stocks.

c. Asymmetric information

We used firm size and order size to proxy asymmetric information. Thirty large firms with the highest market value and thirty small firms with the lowest market value were included in our sample. Following the procedure employed by Lee, Lin and Liu [9], we defined orders with size greater than or equal to 10 (20) lots as big orders; orders with size less than 10 (20) lots are classified as small orders. Both 10 and 20 lots are used as the benchmark in order to test if the results are sensitive to the classification criteria.

d. Market movement

We conducted cross-sectional regression analysis for all stocks to examine the impact of order submission decisions on market performance. Since the order flow in the market and trading activity may be confounding factors, the total orders during 6-minute interval, and relative activity of big versus small orders were used as the independent variables in the regressions. First, total orders in lots for each six-minute interval (TO) and total orders in lots within each call (RUN) were measured. Second, defining the number of big, small and total orders within six minutes as NB, NS and NT, respectively, we measure the relative trading activity of big traders versus small traders by using these ratios: NB/NT and NB/NS. In addition, we measure traders' activity based on total orders in lots. Two ratios, LB/LT and

LB/LS, are calculated, where LB, LS, and LT are the total orders in lots for big, small and total traders.

D. Regression Models

After controlling for market movement, this paper conduct regression models to investigate the impact of order submission decisions on market performance as follows:

$$\text{Liquidity}^A/\text{Liquidity}^B = a + b*TO^A/TO^B (RUN^A/RUN^B) + c*(NB/NT)^A / (NB/NT)^B ((LB/LT)^A /(LB/LT)^B) + d* (RPB^A/RPB^B) + e*(RPS^A/RPS^B) + f*\text{Dummy} + g \qquad (1)$$

$$\text{Volatility}^A/\text{Volatility}^B = a' + b'*TO^A/TO^B (RUN^A/RUN^B) + c'*(NB/NT)^A /(NB/NT)^B ((LB/LT)^A /(LB/LT)^B) + d'* (RPB^A/RPB^B) + e'*(RPS^A/RPS^B) + f' *\text{Dummy} +g' \quad (2)$$

The variables after (before) changes of the trading mechanisms are the numerators (denominators) for both the dependent and independent variables in the regression models. Variables with superscript B (A) denote the value of variables before (after) the change. The liquidity and volatility ratios were used as the dependent variables in the regression models. Liquidity is calculated using the Martin liquidity and Marsh-Rock index. In the regression analysis, we use 6-minute returns. Volatility is defined by the standard deviation of 6-minute returns for stock i during the event period**.** In addition of raw return, 6-minute excess returns using market model are adopted.

Order submission decision variables, RPB^{10}_6 and RPS^{10}_6 (RPB^{20}_6 and RPS^{20}_6, RPB^{10}_{18} and RPS^{10}_{18}, RPB^{20}_{18} and RPS^{20}_{18}) were used as the independent variables. RPB and RPS are the buying and selling reservation price respectively. The superscript indicates whether 10 lots or 20 lots is the classification criteria in defining large and small order. The subscript indicates the time interval in minute. To control for market movement, total orders in lots (TO and RUN) and relative trading activities between big and small traders (NB^{10}/NT, NB^{20}/NT, LB^{10}/LT and LB^{20}/LT) were included as the independent variables. This study used a dummy variable to proxy for firm size; it equals to one for large firm, zero otherwise. g (g') is an error term.

III.   EMPIRICAL RESULTS

A. Market Performance

Table 1 reports the relative market performance under C_{120} versus C_{90} and C_{90} versus C_{90v} in terms of volatility and liquidity. Table 1 indicates that price volatility is consistently higher in the market with higher trading frequency for all volatility indicators. Market liquidity seemed to improve after the market was transferred into a more continuous-like environment. Therefore, a market with more continuous trading performs better in enhancing liquidity but at the expense of higher volatility. Since market trend may be a confounding factor of market performance, we control for market returns using the market model. Market performances controlled for market returns are shown in Table 2. The results of Table 2 are similar to those reported in Table 1. Both price volatility and liquidity are increased in a more continuous-like market. In sum, the findings from Table 1 and Table 2 indicate that there are costs and benefits of switching to a more continuous system.

B. Order Submission Decisions

Table 3 shows the reservation prices 6-minutes (RP_6) and 18-minutes (RP_{18}) before a trader places order under different trading mechanisms. The reported values are the average of RP_6 and RP_{18} across thirty stocks. The results indicate that when the market shifted toward a more continuous trading system, both big and small traders placed smaller reservation prices (RP). Most of the differences on RP before and after changes in trading frequency are negative. The results do yield some support to transaction uncertainty hypothesis suggested by Ho, et al. [6].

Table 1
Volatility and liquidity

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993 (C_{90}), and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993 (C_{90v}). We used 15 days before and after the changes of transaction frequencies as the sample period. Std(R) represents the standard deviation of six-minute returns for stock i during the event period. Six-minute returns are in log form and are measured in terms of percentage. |R| is the absolute value of six-minute returns for stock i during the event period. HLP equals $(\ln(H/L))^2$, the squared value of the highest price over the lowest price in log-form, where H (L) is the highest (lowest) price within six-minute time interval. Park represents [$(\ln H - \ln L)^2 / 4\ln 2$]. R^2_n/Vol_n is the Martin Liquidity Index, where R^2_n is the square value of n-minute returns and Vol_n is the trading shares in lots within n-minute interval. n is replaced again by 6 or 30 minutes. Marsh-Rock measure is denoted by $|R_n|/N_n$, where $|R_n|$ is the absolute value of n-minute returns, N_n is the number of traders within n-minute intervals, and n is replaced by 6 or 30 minutes. Values in the cells are averages of 450 observations (fifteen days * 30 6-minute intervals) across thirty firms. Diff. denotes the difference between the variable before and after change. * represents a significance level of 0.05; ** represents a significance level of 0.01.

| | C120 versus C90 | | | | | | C90 versus C90v | | | | | |
| | Large firm | | | Small firm | | | Large firm | | | Small firm | | |
	C_{120}	C_{90}	Diff.	C_{120}	C_{90}	Diff.	C_{90}	C_{90v}	Diff.	C_{90}	C_{90v}	Diff.
Volatility												
Std(R)	0.3383	0.3454	0.0071	0.4171	0.4219	0.0048	0.3691	0.4426	0.0735**	0.4349	0.5918	0.1569**
|R|	0.1987	0.2015	0.0028	0.2576	0.2644	0.0068	0.2290	0.2883	0.0593**	0.2814	0.3869	0.1055**
HLP	0.0012	0.0015	0.0003**	0.0014	0.0019	0.0005*	0.0017	0.0033	0.0016**	0.0023	0.0061	0.0038**
Park	0.0004	0.0005	0.0001**	0.0005	0.0007	0.0002*	0.0006	0.0012	0.0006**	0.0009	0.0022	0.0013**
Liquidity												
R^2_6/Vol_6	0.0262	0.0274	0.0012	0.0498	0.0454	-0.0044	0.0189	0.0139	-0.0050*	0.0216	0.0224	0.0008
R^2_{30}/Vol_{30}	0.0074	0.0066	-0.0008	0.0251	0.0211	-0.0040	0.0029	0.0031	0.0002	0.0099	0.0064	-0.0035
$|R_6|/N_6$	0.1233	0.1136	-0.0097*	0.1648	0.1422	-0.0226**	0.0989	0.0806	-0.0183**	0.1062	0.0996	-0.0065
$|R_{30}|/N_{30}$	0.0478	0.0407	-0.0071**	0.0747	0.0622	-0.0125**	0.0297	0.0261	-0.0036	0.0411	0.0339	-0.0072

Table 2

Volatility and liquidity: controlled for market trend

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993 (C_{90}), and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993 (C_{90v}). We used 15 days before and after the changes of transaction frequencies as the sample period. We tried to remove market factors using the regression models in calculating market volatility, liquidity and efficiency. To avoid any market movement, market model was conducted using equation (3). Residuals in equation (3) were used to substitute excess returns for a particular stock i. $R_{it} = a + b R_{mt} + R_{et}$ (3) And then, gross returns (R) in Table 1 were replaced by excess returns (R_e) to calculate the indicators of volatility, liquidity and effeciency. The indicators are : $Std(R_{e6})$=standard deviation of six-minute excess returns for stock i during the event period. Six-minute excess returns are the returns after controlled market returns. $|R_{e6}|$ = absolute value of six-minute excess returns for stock i during the event period. Martin Liquidity Index=R^2_{en}/Vol_n, where R^2_{en} is the squared value of n-minute excess returns, Vol_n is the trading shares in lots within n-minute intervals, and n is 6 minutes or 30 minutes. Marsh-Rock=$|R_{en}|/N_n$, where $|R_{en}|$ is the absolute value of six-minute excess returns, N_n is the number of traders within n-minute intervals and where n is replaced by 6 or 30 minutes. Values in the cells are averages of 450 observations (fifteen days * 30 6-minute intervals) across thirty firms. Diff. denotes the difference between the variable before and after change. * represents a significance level of 0.05; ** represents a significance level of 0.01.

| | C_{120} versus C_{90} | | | | | | C_{90} versus C_{90v} | | | | | |
| | Large firm | | | Small firm | | | Large firm | | | Small firm | | |
	C_{120}	C_{90}	Diff.	C_{120}	C_{90}	Diff.	C_{90}	C_{90v}	Diff.	C_{90}	C_{90v}	Diff.
Volatility												
$Std(R_{e6})$	0.3228	0.3328	0.0100	0.3865	0.3907	0.0042	0.3463	0.4101	0.0638**	0.3978	0.5547	0.1569**
$|R_{e6}|$	0.2262	0.2297	0.0035	0.2735	0.2752	0.0017	0.2502	0.3020	0.0518**	0.2860	0.3970	0.1110**
Liquidity												
R^2_{e6}/Vol_6	0.0248	0.0268	0.0020	0.0455	0.0422	-0.0033	0.0180	0.0134	-0.0046*	0.0196	0.0216	0.0020
R^2_{e30}/Vol_{30}	0.0052	0.0061	0.0009	0.0159	0.0167	0.0008	0.0023	0.0026	-0.0003	0.0067	0.0050	-0.0017
$|R_{e6}|/N_6$	0.1372	0.1277	-0.0095	0.1719	0.1478	-0.0241**	0.1084	0.0869	-0.0215**	0.1098	0.1062	-0.0036
$|R_{e30}|/N_{30}$	0.0434	0.0411	-0.0023	0.0620	0.0554	-0.0066	0.0273	0.0229	-0.0044*	0.0353	0.0295	-0.0058

   To test the asymmetric information hypothesis, we compared the reservation prices between big and small traders. In all instances, the reservation prices (RP) for small traders were higher than for big traders. A plausible reason for this phenomenon is that small traders are more uncertain about the possible execution prices so that they place higher (lower) prices to buy (sell). The findings from Table 3 also illustrate that RP is smaller for large firms than for small firms. This implies that traders place higher (lower) reservation buy (sell) prices for small firms due to the higher uncertainty they encounter when they trade small-firm stocks. Moreover, the findings that small traders place higher reservation prices than that placed by big traders are consistent with asymmetric information. And mostly the decrease in reservation prices of small traders is greater than that of big traders.

C. Impact of Order Strategies

Table 3
Reservation prices

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993(C_{90}), and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993(C_{90v}). We used 15 days before and after the changes of transaction frequencies as the sample period. The reservation prices are measured by the weighted average of the order size placed by each trader within six minutes. Reservation price of buy order: $RP_{tji} = \log(P^*_{tji}/P^c_{t-n,ji})$ at interval t, on day j for stock i for big and small traders, where P^*_{tji} is the quote price of any trader at interval t, on day j for stock i; P^c_{t-nji} is the clearing price n minutes before the trader made a quote at interval t, on day j for stock i; n equals to 6 and 18 minutes. On the contrary, reservation price of sell order: $RP_{tji} = \log(P^c_{t-n,ji}/ P^*_{tji})$ at interval t, on day j for stock i for big and small traders. 10 and 20 lots are used to distinguish the traders' types; traders with orders larger than 10 (20) lots are defined as big traders, and vice versa for small traders. Hence, RP_6 and RP_{18} indicate the averages of reservation prices six-minutes and eighteen-minutes before each trader places his order for all orders and across 30 stocks. $Diff^{BS}(RP_n)$ is the difference of RP_n for big versus small orders. Diff. denotes the difference between RP_n before and after change. * represents a significance level of 0.05; ** represents a significance level of 0.01. If the difference of RP_n between large firm and small firm was significant, there would be * and ** marked on the value of RP_n for small firm.

Table 3 (Continued)

| | C_{120} versus C_{90} | | | | | | C_{90} versus C_{90v} | | | | | |
| | Large firm | | | Small firm | | | Large firm | | | Small firm | | |
	C_{120}	C_{90}	Diff.	C_{120}	C_{90}	Diff.	C_{90}	C_{90v}	Diff.	C_{90}	C_{90v}	Diff.
Panel A: 10 Lots												
Big orders												
RP_6	0.0038	0.0037	-0.0001	0.0080	0.0084	0.0004	0.0055	0.0060	0.0005	0.0112	0.0080	-0.0032**
RP_{18}	0.0046	0.0041	-0.0005	0.0088	0.0086	-0.0002	0.0061	0.0066	0.0005	0.0116	0.0085	-0.0031**
Small orders												
RP_6	0.0101	0.0091	-0.0010*	0.0148	0.0160	0.0012	0.0119	0.0115	-0.0004	0.0193	0.0150	-0.0043**
RP_{18}	0.0107	0.0095	-0.0012*	0.0151	0.0160	0.0009	0.0123	0.0119	-0.0004	0.0195	0.0150	-0.0045**
$\text{Diff}^{BS}(RP_6)$	-0.0063**	-0.0054**		-0.0068**	-0.0076**		-0.0064**	-0.0055**		-0.0081**	-0.0070**	
$\text{Diff}^{BS}(RP_{18})$	-0.0061**	-0.0054**		-0.0063**	-0.0074**		-0.0062**	-0.0053**		-0.0079**	-0.0065**	
Panel B: 20 Lots												
Big orders												
RP_6	0.0017	0.0021	0.0004	0.0058**	0.0066**	0.0008	0.0030	0.0043	0.0013*	0.0089**	0.0064*	-0.0025*
RP_{18}	0.0026	0.0027	0.0001	0.0068**	0.0091**	0.0023	0.0037	0.0050	0.0013*	0.0094**	0.0072*	-0.0022*
Small orders												
RP_6	0.0094	0.0084	-0.0010**	0.0140	0.0150**	0.0010	0.0115	0.0113	-0.0002	0.0188	0.0148	-0.0040**
RP_{18}	0.0100	0.0088	-0.0012**	0.0143*	0.0151**	0.0092	0.0119	0.0117	-0.0002	0.0190	0.0149	-0.0041**
$\text{Diff}^{BS}(RP_6)$	-0.0077**	-0.0063**		-0.0082**	-0.0084**		-0.0085**	-0.0070**		-0.0099**	-0.0083**	
$\text{Diff}^{BS}(RP_{18})$	-0.0074**	-0.0061**		-0.0075**	-0.0080**		-0.0082**	-0.0067**		-0.0096**	-0.0077**	

Before examining the impact of order strategies on market performance, we first detected if there were any confounding factors. Total orders in lots for each 6-minute interval (TO) and total orders in lots within each call (RUN) are reported in Table 4. From Table 4, we find that total orders (TO) tend to increase in the trading intervals during the sample period. However, the differences are statistically significant only when the market shifts from C_{90} to C_{90v}. Other things being equal, when the transaction interval is longer, total accumulated orders would increase. Accordingly, we expect that the values of RUN are larger under a less continuous trading system. Surprisingly, however, Table 4 shows that values of RUN are not necessarily larger under a less frequency trading mechanism. In particular, values of RUN are significantly larger when the market adopts a more continuous trading system in two occasions (Panels B and C for C_{90} v.s. C_{90v}). It is plausible that the market was bullish at the time when the market moved towards a more continuous trading design; therefore, both factors would have contributed to price volatility. Another aspect of market movement is the relative willingness to trade between small and big orders. The findings presented in Table 5 reveal that all of the values of NB/NT, NB/NS, LB/LT and LB/LS are larger after the market transfers into a more continuous-like trading system. The results are invariant to the definition of big/small orders. Hence, our results indicate that traders tend to place big orders as time past during the sample period.

By controlling market movements, we run regression on equation (1) and (2) to examine the impact of order submission decisions on market performance. The regression results on liquidity and volatility are shown in Tables 6 and 7, respectively. The coefficients of RP are all negative; however, only the coefficients for small orders are statistically significant. Since the results of Table 3 indicate that as the market shifts to be more continuous, the reservation buy (sell) prices that investors will place decrease (increase). Hence, the results mean that less the decrease in reservation prices placed by small traders, more the increase in market liquidity. It further implies that the higher (lower) reservation buy (sell) prices small orders place, more liquid the market is. Another observation is that the significant coefficients of LB/LT and NB/NT are negative. By definition, a smaller value of the dependent variable indicates higher liquidity, therefore, the resulting negative coefficients mean that market liquidity will increase as big orders increase.

Table 4
Intraday order flow

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993 (C_{90}), and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993 (C_{90v}). This table investigates the order flow during the market opening, intraday period, and the closing, focusing on total orders (buy orders plus sell orders in lots; TO) during each six minute interval and total orders within each call (newly orders entering between two adjacent transactions; RUN). We used six-minute intervals to calculate TO and RUN (in lots) 15 days before and after the changes of transaction frequencies. The values of TO and RUN in the cells are the averages of 450 observations (fifteen days * 30 6-minute intervals) across thirty firms. Diff. stands for the difference between those variables before and after change.
* represents a significance level of 0.05; ** represents a significance level of 0.01.

| | C_{120} versus C_{90} | | | | | | C_{90} versus C_{90v} | | | | | |
| | Large firm | | | Small firm | | | Large firm | | | Small firm | | |
	C_{120}	C_{90}	Diff.	C_{120}	C_{90}	Diff.	C_{90}	C_{90v}	Diff.	C_{90}	C_{90v}	Diff.
Panel A: 9:00-9:30												
TO	232	255	23	116	156	40	368	601	233**	201	357	156**
RUN	101	89	-12	54	53	-1	111	111	0	61	66	5
Panel B: 9:30-11:30												
TO	147	138	-9	72	86	14	228	444	216**	148	209	61**
RUN	59	47	-12	32	29	-3	65	73	8**	42	39	-3
Panel C: 11:30-12:00												
TO	270	220	-50	136	141	5	337	581	244**	228	332	104**
RUN	87	57	-30*	45	37	-8	81	96	15**	54	56	2

Table 5
Trading activities for big versus small traders

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993（C_{90}）, and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993（C_{90v}）. We used 15 days before and after the changes of transaction frequencies as the sample period. This table observes the activities of trade for small and big traders during the changes of trading frequencies. We used 10 and 20 lots of shares to distinguish big orders from small orders. That is, big orders are classified as such for orders that are greater than or equal to 10 (20) lots; while small orders are identified as such for orders that are smaller than 10 (20) lots. We used NB/NT and NB/NS to measure the relative order number of big orders to the total orders and that of the small orders to total orders in order to study the activities of trade for big versus small traders, respectively. Meanwhile, NB, NS and NT represent the number of orders placed by big, small and total traders within six minutes, respectively. We also applied order size in lots (LB/LT and LB/LS) in additions to order number to measure the relative activities of big versus small traders. Values in the cells are the averages of 450 observations (fifteen days * 30 6-minute intervals) across thirty firms. Diff. denotes the difference between the variables before and after change. * represents a significance level of 0.05; ** represents a significance level of 0.01.

Table 5 (Continued)

| | C_{120} versus C_{90} | | | | | | C_{90} versus C_{90v} | | | | | |
| | Large firm | | | Small firm | | | Large firm | | | Small firm | | |
	C_{120}	C_{90}	Diff.	C_{120}	C_{90}	Diff.	C_{90}	C_{90v}	Diff.	C_{90}	C_{90v}	Diff.
Panel A: Lot Size 10												
NB/NT	0.2321	0.2403	0.0082*	0.1895	0.1969	0.0074	0.2593	0.2798	0.0205**	0.2203	0.2341	0.0138*
NB/NS	0.3770	0.3956	0.0186*	0.2947	0.3068	0.0121	0.4226	0.4542	0.0316**	0.3414	0.3561	0.0147
LB/LT	0.5521	0.5583	0.0062	0.4536	0.4763	0.0227	0.6301	0.6944	0.0643**	0.5695	0.6230	0.0535**
LB/LS	4.5867	5.0007	0.4140	2.7433	2.8259	0.0826	4.7582	5.0010	0.2428	3.3116	3.5886	0.2770
Panel B: Lot Size 20												
NB/NT	0.1034	0.1066	0.0032	0.0664	0.0709	0.0045	0.1135	0.1247	0.0112**	0.0868	0.0953	0.0085
NB/NS	0.1432	0.1464	0.0032	0.0879	0.0931	0.0052	0.1505	0.1630	0.0125**	0.1104	0.1180	0.0076
LB/LT	0.3456	0.3472	0.0016	0.2316	0.2561	0.0245	0.4126	0.4846	0.0720**	0.3465	0.4034	0.0569**
LB/LS	2.2898	2.3291	0.0393	1.1308	1.1710	0.0402	2.0635	2.0759	0.0124	1.3356	1.4573	0.1217

Table 6
Regression results: liquidity

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993（C_{90}）, and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993（C_{90v}). We used 15 days before and after the changes of transaction frequencies as the sample period. This table conducts regression models to examine the impact of order submission decisions on liquidity. Measures of liquidity that are calculated from Table 2 are used as the dependent variables, respectively, in the regression models. Six-minute excess returns are the returns after controlled market returns. Martin Liquidity Index=R^2_{en}/Vol_n, while R^2_{en} is the squared value of 6-minute excess returns and Vol_n is the trading shares within n-minute interval, where n is 6 minutes. Marsh-Rock=$|R_{e6}|/N_n$, while $|R_{e6}|$ is the absolute value of six-minute excess returns. N_n is the number of traders within 6-minute interval. Order submission decisions variables are used as the independent variables, which can be obtained from Tables 3, Table 4 and Table 5. They are used to substitute for market activity (TO and RUN), relative trading activities of trader types (NB^{10}/NT, NB^{20}/NT, LB^{10}/LT and LB^{20}/LT) and reservation prices (RPB^{10}_6, RPB^{20}_6, RPS^{10}_6 and RPS^{20}_6). This study uses dummy variable to substitute for firm size; if the firm size is large, then it belongs to 1, otherwise, it is 0. The variables after (before) changes of the trading mechanisms are treated as the numerators (denominators) of both of the dependent variables and the independent variables in the regression models. + represents a significance level of 0.1; * represents a significance level of 0.05; ** represents a significance level of 0.01.

Table 6 (continued)

dep.	Indep. period	RPB$^{10}_6$	RPS$^{10}_6$	RPB$^{20}_6$	RPS$^{20}_6$	TO	RUN	LB^{10}/LT	LB^{20}/LT	NB^{10}/NT	NB^{20}/NT	Intercept	Dummy	Adj-R^2
(Re_6^2) / Vol$_6$	C$_{90}$/C$_{120}$	-0.1743	-1.3043*			-0.3986		-0.2078				3.2795**	0.2632	0.2005
				-0.0754	-1.3035*	-0.1445			-1.0450			3.8227**	0.2370	0.2196
		-0.1744	-1.2990*			-0.4385				0.0134		3.0971**	0.2582	0.1993
				-0.0686	-1.2178*	-0.3638					-0.7260	3.6213**	0.2772	0.1998
		-0.1409	-1.3435*				-0.9758+	0.1804				3.3369**	0.2971	0.2277
				-0.0676	-1.2381*		-0.5632		-0.7261			3.7559**	0.2748	0.2302
		-0.1391	-1.3386*				-0.9887*			0.3349		3.1876**	0.2858	0.2299
				-0.0600	-1.1982*		-0.8467+				-0.4207	3.6206**	0.3245	0.2211
	C$_{90v}$/C$_{90}$	0.0302	-2.4452**			0.0751		-2.1769*				5.7249**	-0.3828+	0.4188
				-0.0290	-2.0617**	0.1342			-0.8892+			4.0698**	-0.4924*	0.3762
		0.0228	-2.3346**			-0.0321				-1.7227*		5.2779**	-0.3622	0.4125
				-0.0120	-1.9764**	0.0049					-0.5692	3.7765**	-0.4591+	0.3582
		0.0311	-2.3499**				0.1553	-2.1757*				5.6061**	-0.3932+	0.4179
				-0.0152	-1.9179**		0.1333		-0.7269			3.8288**	-0.4842+	0.3708
		0.0227	-2.3772**				-0.0894			-1.6824*		5.3111**	-0.3556	0.4128
				-0.0077	-1.9719**		-0.0729				-0.4955	3.7736**	-0.4479+	0.3588
| Re$_t$ | /N$_6$	C$_{90}$/C$_{120}$	-0.0115	-0.2507**			-0.0427		-0.1602				1.3533**	0.0349	0.2984
				-0.0107	-0.2374**	-0.0284			-0.1387			1.3064**	0.0355	0.3013
		-0.0119	-0.2475**			-0.0665+				-0.0597		1.2765**	0.0340	0.2717
				-0.0073	-0.2104**	-0.0674+					-0.0234	1.1902**	0.0466	0.2696
		-0.0117	-0.2870**				0.0186	-0.2289*				1.3838**	0.0442	0.2847
				-0.0125	-0.2805**		0.0660		-0.2310*			1.3535**	0.0335	0.3045
		-0.0099	-0.2886**				-0.0464			-0.0783		1.2912**	0.0462	0.2364
				-0.0068	-0.2464**		-0.0572				-0.0343	1.2042**	0.0576	0.2359
	C$_{90v}$/C$_{90}$	0.0043	-0.8579**			0.0438		-0.2205				1.8098**	-0.0209	0.4821
				-0.0086	-0.7926**	0.0827+			-0.1626			1.6681**	-0.0490	0.5012
		0.0035	-0.8478**			0.0336				-0.1872		1.7780**	-0.0188	0.4823
				-0.0053	-0.7764**	0.0585+					-0.1007	1.6109**	-0.0426	0.4922
		0.0037	-0.7837**				0.3164**	-0.6752**				1.9821**	-0.0510	0.5969
				-0.0139	-0.6789**		0.3839**		-0.3555**			1.5367**	-0.0898+	0.6337
		0.0020	-0.7916**				0.2214**			-0.4020*		1.7796**	-0.0377	0.5468
				-0.0102	-0.7053**		0.2829**				-0.2419*	1.5093**	-0.0721	0.5932

In Table 7, we find that most of the coefficients of the reservation prices are negative and are significant for small traders. In addition, the coefficients of total orders are all positive and statistically significant, while most of the coefficients of traders' activity are negative but insignificant. Table 3 shows that the reservation prices are larger, especially for small traders in a less continuous trading market rather than in a more continuous-like one. Table 7 suggests that firms experiencing less reduction in reservation buy (sell) price as offered by small traders have less increase in volatility. It implies that the higher the reservation prices placed by small traders, the less volatile the market will be. This suggests that small traders, placing buy (sell) orders at higher (lower) prices induces market depth and may help absorb incoming orders from the counterpart side, and thus, aid in reducing price volatility in a less continuous trading market. On the other hand, most of the coefficients of reservation prices in Table 7 for big traders are insignificant. There is weak evidence to show that higher reservation prices placed by big traders will eventually lead to higher volatility. However, the impact of big traders on market volatility is very slight. In a less continuous market, small traders also place higher (lower) reservation buy (sell) prices, they offer additional depth to the market. This reduces the market volatility induced by big traders' transactions; accordingly, the impact of big orders is reduced.

IV. CONCLUSIONS

Past theoretical works on the comparison of call and continuous markets have explored the relationships between trading arrangements and order submission decisions, between order submission decisions and market performance, and that of trading arrangements, order submission decisions, and market performance. On the other hand, relevant empirical studies have been conducted to look into the relationships between trading arrangements and market performance, and between order submission decisions and market performance.

Table 7
Regression results: volatility

The TWSE conducted an electronic call market with two-minute transaction frequencies from August 2 to September 12, 1993 (C_{120}). The market changed its frequencies from two minutes to 90 seconds during the period of September 13 and November 1, 1993 (C_{90}), and from 90 seconds to one or two transactions per 90 seconds since November 2, 1993 (C_{90v}). We used 15 days before and after the changes of transaction frequencies as the sample period. This table conducts regression models to examine the impact of order submission decisions on volatility. Measures of volatility that are calculated from Table 2 are used as the dependent variables, in the regression models. $Std(R_6)$ represents the standard deviation of six-minute excess returns for stock i during the event period. Six-minute excess returns are the returns after controlled market returns. $|R_6|$ is the absolute value of six-minute excess returns for stock i during the event period. Order submission decision variables are used as the independent variables, which can be obtained from Tables 3, Table 4, and Table 5. They are used to substitute for market activity (TO and RUN), relative trading activities of trader types (NB^{10}/NT, NB^{20}/NT, LB^{10}/LT and LB^{20}/LT) and reservation prices (RPB^{10}_6, RPB^{20}_6, RPS^{10}_6 and RPS^{20}_6). This study uses a dummy variable to substitute for firm size; if the firm size is large, then it belongs to 1, otherwise, it is 0. The variables after (before) changes of the trading mechanisms are treated as the numerators (denominators) for both of the dependent variables and the independent variables in the regression models. + represents a significance level of 0.1; * represents a significance level of 0.05; ** represents a significance level of 0.01.

Table 7 (continued)

dep.	Indep. period	RPB$^{10}_6$	RPS$^{10}_6$	RPB$^{20}_6$	RPS$^{20}_6$	TO	RUN	LB^{10}/LT	LB^{20}/LT	NB^{10}/NT	NB^{20}/NT	Intercept	Dummy	Adj-R^2
				Reservation Prices		Market		Trader 's Activity						
Std(Re$_6$)	C$_{90}$/C$_{120}$	-0.0081	-0.1028			0.1372**		-0.1031				1.0548**	0.0341	0.1964
				0.0066	-0.1299*	0.1493**			-0.0766			1.0233**	0.0404	0.2313
		-0.0085	-0.1014			0.1272**				-0.0926		1.0547**	0.0358	0.1931
				0.0077	-0.1196*	0.1307**					-0.0347	0.9857**	0.0448	0.2174
		-0.0167	-0.0648				0.2420**	-0.1527				1.0165**	0.0181	0.1995
				0.0046	-0.0975+		0.2660**		-0.1291			0.9847**	0.0182	0.2128
		-0.0166	-0.0671				0.2197**			-0.1421+		1.0278**	0.0226	0.1980
				0.0055	-0.0931		0.2198**				-0.0873	0.9740**	0.0260	0.1949
	C$_{90v}$/C$_{90}$	0.0135	-0.7951**			0.2905**		-0.4348+				2.0276**	-0.1452*	0.6412
				-0.0050	-0.6848**	0.2902**			-0.0926			1.5959**	-0.1625*	0.6278
		0.0121	-0.7723**			0.2686**				-0.3356		1.9293**	-0.1410*	0.6382
				-0.0018	-0.6702**	0.2715**					-0.0285	1.5327**	-0.1566*	0.6248
		0.0167*	-0.4195**				0.6832**	-0.5955*				1.6554**	-0.1941**	0.6096
				0.0122	-0.3510**		0.5615**		-0.0067			1.0902**	-0.1863**	0.5718
		0.0141	-0.4272**				0.6234**			-0.5061*		1.6169**	-0.1044**	0.6125
				0.0114	-0.3512**		0.5673**				-0.0245	1.1048**	-0.1880**	0.5721
| Re$_6$ |	C$_{90}$/C$_{120}$	-0.0015	-0.0750			0.1400**		-0.1059				1.0104**	0.0328	0.2398
				0.0095	-0.0980+	0.1441**			-0.0501			0.9545**	0.0408	0.2799
		-0.0020	-0.0737			0.1305**				-0.1038		1.0183**	0.0349	0.2404
				0.0101	-0.0921+	0.1325**					-0.0270	0.9352**	0.0434	0.2741
		-0.0101	-0.0343				0.2394**	-0.1498+				0.9699**	0.0161	0.2248
				0.0078	-0.0627		0.2444**		-0.0898			0.9130**	0.0201	0.2362
		-0.0101	-0.0368				0.2203**			-0.1513+		0.9907**	0.0209	0.2313
				0.0080	-0.0631		0.2176**				-0.0767	0.9226**	0.0242	0.2332
	C$_{90v}$/C$_{90}$	0.0116	-0.7689**			0.2508**		-0.2666				1.8649**	-0.0970+	0.6355
				-0.0079	-0.6600**	0.2522**			-0.0343			1.5473**	-0.1139*	0.6298
		0.0.06	-0.7566**			0.2386**				-0.2270		1.8272**	-0.0945+	0.6359
				-0.0059	-0.6511**	0.2421**					0.0079	1.5042**	-0.1102+	0.6293
		0.0143+	-0.4444**				0.5920**	-0.4096				1.5458**	-0.1395*	0.6092
				0.0067	-0.3694**		0.4934**		0.0351			1.1080**	-0.1354*	0.5830
		0.0123	-0.4499**				0.5562**			-0.3818+		1.5504**	-0.1333*	0.6151
				0.0058	-0.3666**		0.5093**				0.0085	1.1224**	-0.1387*	0.5824

This study contributes to the literature by examining the relations among trading arrangements, order submission decisions, and market performance simultaneously. We investigate the order submission decision by comparing the market performance before and after changes of trading frequency. A special feature of this study is to examine how traders react when there are changes in trading mechanisms. We find that traders tend to place higher (lower) reservation buy (sell) prices to reduce transaction price uncertainty when in a market with asymmetric information and less frequent trading market. The regression results show that as the market transits to be more continuous-like, a lower reservation price placed by small orders will result in higher market liquidity and lower volatility. This result aligns with the finding of Ahn, et al. (2000), which shows that limit traders provide liquidity to the market. Our findings imply that in a less continuous market, higher (lower) reservation buy (sell) prices placed by small traders enhance market depth and reduce market volatility caused by big traders' transaction.

ACKNOWLEDGEMENTS

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