

Explaining Intraday Pattern of Trading Volume from the Order Flow Data

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1. INTRODUCTION

Extensive studies have documented a pattern of usually large trading volume at the market open, and in particular at the close in the New York Stock Exchange and Toronto Stock Exchange. For example, Wood, McInish and Ord (1985), McInish and Wood (1990a), McInish and Wood (1992) and Lockwood and Linn (1990) found U-shaped patterns for intraday returns and trading volume. Similar patterns have also been explored in some Asian stock markets. For instance, Chow, Lee, Liu and Liu (1994), Ho and Cheung (1991), as well as Ho, Cheung and Cheung (1993) found extremely large trading volume at the close in the Taiwan and Hong Kong stock markets. Hence, large trading volume around market open and close is a global phenomenon.

Many researchers dedicate their efforts to explain why such patterns exist. McInish and Wood (1990b), Harris (1989) and Porter (1992) suggested that day-end effects might account for the pattern. Since different markets show similar intraday patterns of trading volume, trading mechanisms may not be

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responsible for the patterns. Information asymmetry has recently been proposed as one of the possible explanations for the pattern. Admati and Pfleiderer (1988 and 1989) pioneered to construct a model and demonstrated that liquidity traders tend to trade together to reduce the monopoly power of insiders. The clustering of uninformed traders draws informed traders to the market because informed traders benefit more from their private information when noise traders trade. Using an information-based model, Foster and Viswanathan (1990) contended that information is accumulated during non-trading periods. Therefore, informed traders may wish to enter the market as soon as possible; otherwise, their private information will be gradually revealed as transactions take place.

Brock and Kleidon (1992) proposed the risk-sharing motivation. They suggested that day traders tend to shift the risk of holding positions overnight to other traders. Following the insight of Brock and Kleidon (1992), Gerety and Mulherin (1992) asserted that traders who perform arbitrage functions during active trading do not want to retain their holdings overnight. Their results indicate that closing volume is related to the expected overnight volatility underscoring risk-sharing motives. Additionally, the expected and unexpected volatility will affect the next open volume, which supports both the risk-sharing motives and information asymmetry hypothesis. Using a mathematical model, Slezak(1994) showed that closures delay the resolution of uncertainty, and thus redistribute risk across time and traders. As a consequence, the redistribution alters risk premium, liquidity costs, and the degree of information asymmetry.

All of these studies, except Gerety and Mulherin (1992), are theoretical researches. Gerety and Mulherin (1992) adopted Schwert's model to estimate the expected and unexpected volatility. They validate the information asymmetry and risk-sharing hypothesis in explaining trading volume. However, they did not address how informed and uninformed traders behave during the intraday periods. Studies on intraday trading yield important policy implication. For example, Gerety and Mulherin (1992) drew inference on the effect of trading halt from the behavior of trading volume around market close. As Bessembinder, Chan and Seguin (1996) claimed, 'Despite the

importance of the topic, surprisingly little empirical research has addressed the determinant of trading volume.' To date, there is no close-up study on the trading behavior of different types of investors and its impact on the intraday trading volume pattern.

This study extends the literature by examining the relationship between investors' trading behaviors and trading volume during intraday periods. The pivotal contribution of this study is to track the intraday trading behavior of informed and uninformed investors directly using a complete limit order book data of the Taiwan Stock Exchange. We examine the intraday pattern of information orders and liquidity orders as well as the ordering strategies of both informed and uninformed (liquidity) traders.

The study finds the following important pattern of intraday trading: First both informed and uninformed investors tend to place more orders at both the market open and the close. Second, real orders exhibit a J-shaped pattern while waiting orders are in a reversed J-shaped pattern. Third, the impact of liquidity trading on volume is relatively larger than that of the information trading.

In this study, we use order flow data from the Taiwan stock market (TWSE). The data allows us to examine investors' trading behaviors directly. There are several merits of using the order flow data: (1) We can exclude the impact of trading rules of execution; (2) TWSE is an agent market. Using the data from the market excludes the influences of dealer or specialist systems in the investigation of intraday patterns of trading volume; (3) Previous studies have used location in spreads to proxy for relative pressure of buy and sell orders. As pointed out by Lee and Ready (1991), these measurements may be biased. With order flow data, we can identify directly whether a trade is buyer-initiated or seller-initiated; (4) It allows us to construct proxies for information trading and liquidity trading.

The following section investigates the intraday pattern of trading volume in the Taiwan stock market based on the intraday transaction data from March 1 to May 31, 1995. Testable hypotheses are constructed and variables used in the regression analysis are defined in Section 3. Empirical results are provided in Section 4. Finally, concluding remarks are made in Section 5.

2. INTRADAY PATTERN OF TRADING VOLUME

(i) Data Descriptions

The Taiwan stock market uses a call system except for the open. For the open trade, orders with the same price are matched randomly. For other time intervals, orders are matched based on price-time priority. The market opens a call at 9:00 A.M. by accumulating the entering orders from 8:30 A.M. to 9:00 A.M. The calls during the remaining periods (from 9:00 to 12:00, excluding the open trade) are executed for one minute on average (for more details, see Chow, Hsiao and Liu, 1999). It is an agency market in which no dealers or specialists are involved in the market. Thus, using the data from the Taiwan stock market enables us to investigate intraday patterns in a way that results are not contaminated by different auction mechanisms in various intraday trading periods. Furthermore, since most stocks in the Taiwan stock market are actively traded, our results are not likely affected by nonsynchronous trading.

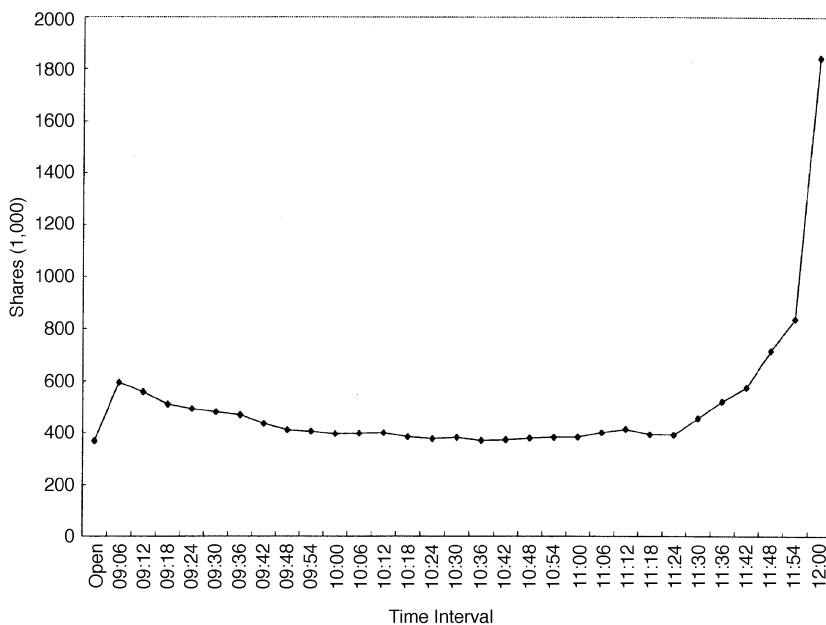
Order flow data and transaction data from the Taiwan stock market under study is for the period from March 1 to May 31, 1995. We have an electronic complete limit order book which provides data on all trades including quotations, buy or sell-initiated shares in lots and time-stamped. The data allows us to identify different types of investors and their trading behaviors. In addition, the data avoids the bias that may be caused by only investigating part of the order flow files (e.g. Biais, Hillion and Spatt, 1995).

In order to distinguish traders' real trading intention versus desire for information, data from individual stocks instead of the market indices are examined. We analyze the 30 most actively traded stocks in the sample period. The 30 stocks account for more than 46% of the total market value of the stocks traded in the TWSE, therefore, the sample is representative.

(ii) Intraday Pattern of Trading Volume

The intraday pattern of trading volume for our sample firms across 31 time intervals is summarized in Figure 1. The first point represents the open trade. The others are six-minute intervals. Previous studies find a U-shaped pattern for trading volume. Figure 1 indicates a different pattern for our sample firms.

Figure 1
Intraday Volume



Surprisingly, a J-shaped rather than a U-shaped pattern is found. The lowest trading volume occurs at the open trade. This could not be due to late reporting because the calls in the TWSE are executed no more than 90 seconds on average. The trading shares jump up at 9:06, taper through the interior periods gradually, and rise rapidly at the end of the trading day, especially for the last six minutes. F test results indicate that trading volume at the market close is statistically different from that of the open trade and from those in the interior periods (9:06–11:54): $F_{\text{open, close}}$ and $F_{\text{close, inn}}$ are 20.2 and 17.54 respectively, where F stands for F-statistic, ‘open’ represents the open trade, ‘inn’ represents the interior periods from 9:06 to 11:54, and ‘close’ represents the last trade interval (11:54–12:00). However, trading volume at the open is not significantly different from those of the other time intervals excepting the last trading interval (11:54–12:00).

The J-shaped pattern does not necessarily contradict to the findings reported in previous studies. As Foster and Viswanathan (1990) reported, less active firms show a more pronounced U-

shaped pattern of trading volume. Our sample includes the most active stocks in the Taiwan market, so it is not surprising to find a less pronounced U-shaped pattern. Moreover, if the open trade is included into the 9:00–9:06 interval, trading volume confers more closely to a U-shaped pattern. Nevertheless, Figure 1 shows that trading volume is extremely large at the market close, i.e., a closure effect is evident.

3. TESTING HYPOTHESES AND MEASUREMENT OF VARIABLES

(i) *Testable Hypothesis*

In the following, we investigate how trading volume is related with the trading behaviors of informed and uninformed traders. Firstly, we examine if concentrated trading exists during the intraday period. Secondly, we investigate whether informed traders and uninformed traders cluster their orders at the market open and the close. Finally, we examine the ordering strategy of informed and uninformed traders by decomposing total orders into real and waiting orders. The testing hypotheses are listed below.

H₁: Investors tend to place more orders at the open and the close than at the interior periods.

Admati and Pfleiderer (1988 and 1989) showed mathematically that concentrated trading exists at the market open and the close. They demonstrated that liquidity traders tend to trade together to reduce the monopoly power of insiders. The clustering of uninformed traders draws informed traders to the market. However, trading volume may not be a good proxy for trading intention of investors, since trading volume may also be affected by trading rules of execution. In particular, if the trading rules for the open, close and the rest of the trading periods are different, results based on trading volume may be biased.

To examine if large trading volume implies concentrated trading, this study adopts original entering orders to examine the traders' desires to place their orders. We hypothesize that investors tend to place more orders at the market open and the close than at the interior periods. Therefore, clustering orders are expected around the market open and the close.

H₂: The clustering of informed and uninformed traders at market open and the close contribute to the intraday pattern.

Admati and Pfleiderer (1988 and 1989) demonstrated that liquidity traders and informed traders tend to cluster their trade at the open and close. Foster and Viswanathan (1990) contended that informed traders might wish to enter the market at the open to avoid revealing their private information. In order to examine these arguments, we classify total orders into informed and uninformed orders (or liquidity orders). We hypothesize that informed orders and uninformed orders at the open and the close are larger than those at the rest of the trading intervals. Furthermore, concentrated trading by informed and uninformed traders accounts for the intraday pattern of trading volume.

H₃: Traders place orders strategically and conservatively at the market open.

Slezak(1994) proved that closures delay the resolution of uncertainty, thereby redistributing risk across time and traders. We hypothesize that traders strategically place their orders due to closure effects. Due to high uncertainty generated from non-trading periods, traders place their orders conservatively at the market open.

(ii) Measurement of Variables

To test the aforementioned hypotheses, we need to measure investor's trading desire and identify whether an investor is an informed or uninformed trader. Measurements of the key variables used in this study are defined in the following section:

(a) Traders Desires

The indicators listed below are used to measure trading desires of investors. $B_{i,t}$ ($S_{i,t}$) represents total buy (sell) orders at interval i on day t . Orders are expressed in terms of trading lots (LOT) and number of orders (NUM). The measurement interval, i , is six minutes. There is always a trade-off between price priority and waiting costs for traders to place their orders. If traders place a low (high) price to buy (sell) stocks, they prefer to wait for a good

opportunity to get better prices. Such orders may be invalid for execution and reflect desires for price priority rather than real trading intention. On the contrary, if traders place a high (low) price to buy (sell) stocks, they show great intention to have their orders being executed. Such orders represent real trading intention rather than desires for price priority. Therefore, we classify total orders into two categories. Real buy (sell) orders at interval i on day t , $RB_{i,t}$ ($RS_{i,t}$) are buy (sell) orders that are greater (lower) than or equal to two ticks from the previous transaction prices. Waiting buy (sell) orders at interval i on day t , $UB_{i,t}$ ($US_{i,t}$), are orders that are lower (greater) than or equal to two ticks from the previous transaction prices. If investors have strong desires to place their orders at market open and close, we would find U-shaped patterns for real buy and sell orders.

(b) Informed Traders and Uninformed Traders

Past theoretical studies suggested that trading volume is partially determined by the interaction of informed and uninformed traders. Unfortunately, previous studies fail to measure trading activity of informed and uninformed traders due to data limitation. With a complete limit order book, we can construct proxies for informed trading and liquidity trading. We classify investors as informed and uninformed traders based on the order size in terms of trading lots. Two lines of researches can rationalize the use of order size to define informed and uninformed traders. Easley and O'Hara (1987) argued that informed traders tend to trade large amounts at any given price. The stealth trading hypothesis proposed by Barclay and Warner (1993) hypothesized that informed traders tend to place medium to large orders. Recently, Lee, Lin and Liu (1999) provided evidence that big individual investors are the most well informed traders on the Taiwan Stock Exchange. Moreover, they found that small orders (uninformed orders) provide liquidity to the market.

In this study, orders with size greater than or equal to 20 lots are defined as informed orders, and uninformed orders (or liquidity orders) are orders with less than 20 lots. The choice of 20 lots as the cutting point is arbitrary. Nevertheless, 20 lots would be regarded as a medium trade size in the TWSE. As the stealth trading hypothesis suggests, informed traders tend to split

their transaction into several medium trades. In addition, Lee, Lin and Liu (1999) also defined informed and uninformed trades based on order size. They found that a cutting point of 10 lots and 20 lots yielded similar empirical results.

4. EMPIRICAL RESULTS

(i) Trading Behaviors of Informed and Uninformed Traders

The distribution of buy and sell orders across the 31 time intervals is shown in Table 1a. Orders are measured in terms of lots (LOTS) and the number of orders (NUM). The first session (OPEN) indicates the orders accumulated from 8:30 up to the first trade. The others are six-minute intervals. The times shown in the first column of Table 1a indicate when a six-minute interval is ended. For example, the second interval '9:06' stands for the time period from 9:00 to 9:06 excluding the first trade. The last interval '12:00' stands for the interval from 11:54 to 12:00. The time interval from 9:06–11:54 is defined as the interior period, 'inn'. Regardless of the measurement unit, investors' orders display an unambiguous U-shape pattern. Total order is the largest at the open, and the second largest order appears at the market close. F-statistics indicate that total orders at the open and the close are significantly different from those in the interior periods ($F_{\text{-open,inn}} = 28.41$; $F_{\text{-close,inn}} = 11.62$). The finding supports the first hypothesis, that is, investors tend to cluster their orders at the market open and the close.

Trading lots and the number of orders at the open are almost two times of those at the market close. A detailed examination of Table 1a indicates that this is mainly driven by the behavior of sell orders. Sell orders dominate buy orders at the market open. Sell LOTS and NUM are 2719.49 and 257.36, respectively, compared with 1760.35 and 180.24 for the buy LOTS and NUM. There is a relatively small difference between buy orders at the open and those at the close. Moreover, at the market close, the sizes of sell and buy orders are similar. Buy LOTS and NUM are 1164.28 and 105.25, respectively, compared with sell LOTS and NUM 1151.65 and 102.99 respectively at the close. The large sell order at the open could be a reflection of a high level of uncertainty.

Table 1a
Buy and Sell Orders

	<i>BUY</i>		<i>SELL</i>		<i>TOTAL(B+S)</i>	
	<i>LOTS</i>	<i>NUM</i>	<i>LOTS</i>	<i>NUM</i>	<i>LOTS</i>	<i>NUM</i>
Open	1760.35	180.24	2719.49	257.36	4479.84	437.60
9:06	602.81	52.99	694.13	57.18	1296.94	110.17
9:12	604.89	55.39	708.67	66.99	1313.56	122.38
9:18	560.28	52.60	587.43	57.00	1147.71	109.61
9:24	541.58	50.42	531.83	51.51	1073.41	101.94
9:30	484.80	46.36	513.14	49.97	997.93	96.33
9:36	473.05	43.99	508.72	48.78	981.77	92.77
9:42	445.80	43.01	461.68	45.40	907.48	88.41
9:48	391.69	39.38	429.67	42.29	821.36	81.67
9:54	380.62	37.69	412.28	41.04	792.90	78.73
10:00	364.86	36.34	409.96	40.41	774.82	76.75
10:06	392.37	38.65	386.31	37.99	778.67	76.64
10:12	387.12	38.31	393.43	38.74	780.54	77.05
10:18	378.69	37.16	373.90	36.58	752.58	73.74
10:24	351.54	35.10	348.03	34.46	699.57	69.57
10:30	349.87	33.77	359.54	35.00	709.41	68.77
10:36	329.60	33.08	350.43	33.42	680.04	66.50
10:42	335.88	33.91	346.79	33.06	682.67	66.97
10:48	348.37	35.59	324.18	31.47	672.54	67.06
10:54	362.24	36.76	331.82	31.89	694.06	68.65
11:00	347.51	35.35	339.35	32.82	686.86	68.17
11:06	335.39	32.60	368.22	34.54	703.61	67.14
11:12	353.05	34.68	376.94	35.67	729.99	70.35
11:18	349.60	35.04	354.70	34.16	704.30	69.21
11:24	359.91	36.53	327.70	32.82	687.60	69.35
11:30	390.59	38.80	374.85	35.83	765.44	74.63
11:36	428.38	41.02	423.74	40.02	852.12	81.04
11:42	474.11	45.92	445.50	42.77	919.61	88.69
11:48	582.22	55.89	510.43	48.90	1092.65	104.79
11:54	662.32	66.31	600.93	58.05	1263.25	124.36
12:00	1164.28	105.25	1151.65	102.99	2315.93	208.24
AVERAGE	500.41	48.64	540.164	51.464	1024.49	98.62
F-all	9.96**	17.36**	20.28**	28.41**	15.38**	23.30**
F-open, 9:06	13.19**	25.14**	25.66**	35.18**	20.47**	31.03**
F-open, inn	18.92**	31.58**	34.77**	42.33**	28.41**	37.99**
F-open, close	2.71	6.79*	12.94**	18.73**	7.62**	12.89**
F-9:06, inn	2.11	1.47	4.10*	2.61	3.07	2.02
F-9:06, close	6.04*	8.76**	3.72	7.88**	4.81*	8.40**
F-close, inn	12.17**	14.65**	11.04**	16.51**	11.62**	15.64**

Notes:

Orders are expressed in terms of lots (LOTS) and number of orders (NUM). One lot equals to 1,000 shares. F stands for F-statistic; 'all' represents all trade intervals; 'open' represents the open trade; '9:06' represents the first six-minute interval (9:00–9:06) excluding the open trade; 'inn' represents interior periods from 9:06 to 12:00; 'close' represents the last trade interval (11:54–12:00). *, ** indicates significance at the 1% and 10% levels, respectively.

Table 1b
Order/Volume Ratio and Order Price Spread

<i>Time Interval</i>	<i>Order/Volume Ratio</i>	<i>Order Price Spread</i>
Open	27.7995	1.64398
9:06	4.7335	-0.34812
9:12	4.5707	-0.25677
9:18	4.2773	-0.29271
9:24	4.2927	-0.34481
9:30	3.5854	-0.39852
9:36	3.5945	-0.39353
9:42	3.9469	-0.43050
9:48	3.3957	-0.43947
9:54	3.3979	-0.44465
10:00	3.4905	-0.51876
10:06	3.3758	-0.52619
10:12	3.3008	-0.54541
10:18	3.1984	-0.55570
10:24	3.3374	-0.58733
10:30	3.2276	-0.65403
10:36	3.2233	-0.62710
10:42	3.1608	-0.63968
10:48	3.0454	-0.64929
10:54	2.8778	-0.69568
11:00	2.7656	-0.71159
11:06	3.0240	-0.72560
11:12	2.8690	-0.74839
11:18	2.8316	-0.83204
11:24	2.6757	-0.84706
11:30	2.4353	-0.91175
11:36	3.0604	-0.95526
11:42	2.2635	-1.09502
11:48	1.9511	-1.24558
11:54	1.7914	-1.47301
12:00	1.3044	-2.53481
AVERAGE	3.9614	-0.63821
F-all	65.72**	62.48**
F-open, 9:06	77.50**	148.61**
F-open, inn	95.04**	246.18**
F-open, close	110.83**	289.81**
F-9:06, inn	4.19*	8.58**
F-9:06, close	22.09**	95.34**
F-close, inn	75.98**	77.82**

Notes:

Orders and volume in a certain trade session are expressed in terms of lots (LOTS). One lot equals to 1,000 shares. Order price spread of a stock equals to average selling price minus average buying price for the stock in a certain trade session. F stands for F-statistic; 'all' represents all trade intervals; 'open' represents the open trade; '9:06' represents the first six-minute interval (9:00-9:06) excluding the open trade; 'inn' represents interior periods from 9:06 to 12:00; 'close' represents the last trade interval (11:54-12:00).

*, ** indicates significance at the 1% and 10% levels, respectively.

Interestingly, while the largest total order appears at the open, trading volume (as shown in Figure 1) is at its peak at the market close. Table 1b shows the order/volume ratio and the order price spread (OPS). Order price spread of a stock equals average selling price minus average buying price for the stock in a certain trade session. The number shown in Table 1b is the average OPS of the 30 sample firms. The order/volume ratio is extremely high at the open and then decreases gradually. On the other hand, OPS is positive at the open but becomes negative afterwards. A high order/volume ratio and a large OPS imply a low chance for orders to be executed and vice versa. Therefore, Table 1b further illustrates that many of the orders placed at the open are not executable. As investors may place orders conservatively, total order may not be a good measure of real trading intention. Therefore, it is important to distinguish real orders from waiting orders – the orders which are less likely to be executed.

To examine why large open orders do not lead to large trading volume, we decompose total orders into real and waiting orders. This decomposition is important to identify the real trading intention of investors. To 'test' the market, investors may place orders that are not likely to be executed. As defined earlier, real buy (sell) orders are those that have quotes greater (lower) than or equal to two ticks from the previous transaction prices. Buy (sell) orders that have quotes lower (greater) than or equal to two ticks from the previous transaction prices are classified as waiting orders.

As shown in Table 2, the largest waiting orders occur at the open. Only 38% [$664.71/(664.71 + 1095.64)$] of buy orders and 31% [$(839.11/(839.11 + 1880.38))$] of sell orders at the open are real orders. Waiting orders dramatically decrease after the market open and become stable after one hour of trading. This is probably due to high uncertainty existing at the market open. As information releases gradually, investors are willing to place more executable orders. Therefore, waiting orders decrease continuously since the open trade. Regardless of the fact that waiting orders increase slightly at the market close, real buy and real sell orders are the largest at the market close. About 93% ($1082.14/1164.28$) of buy orders and 94% ($1083.06/1151.65$) of sell orders are real orders. This implies that through trading, private information is revealed and traders are less conservative at the close than at the open. To sum up, results from Table 2

Table 2
Real and Waiting Orders in Terms of Lots in Trades

<i>Time Interval</i>	<i>Real Orders</i>		<i>Waiting Orders</i>	
	<i>BUY</i>	<i>SELL</i>	<i>BUY</i>	<i>SELL</i>
Open	664.71	839.11	1095.64	1880.38
9:06	476.81	475.80	126.00	218.33
9:12	475.25	520.70	129.64	187.97
9:18	457.59	442.16	102.69	145.27
9:24	443.85	411.04	97.74	120.81
9:30	412.90	399.52	71.90	113.63
9:36	388.05	410.00	85.00	98.73
9:42	371.87	378.04	73.93	83.63
9:48	331.70	356.98	59.99	72.68
9:54	321.35	344.56	59.26	67.70
10:00	314.12	340.88	50.73	69.06
10:06	322.68	320.91	69.78	65.41
10:12	325.07	334.51	62.04	58.92
10:18	323.26	318.26	55.43	55.64
10:24	304.92	303.07	46.54	44.95
10:30	305.78	312.88	44.09	46.67
10:36	286.06	303.76	43.54	46.68
10:42	292.19	304.13	43.69	42.66
10:48	305.76	281.24	42.60	42.94
10:54	322.99	288.16	39.26	43.66
11:00	304.65	298.17	42.86	41.18
11:06	297.80	325.87	37.59	42.35
11:12	308.71	335.20	44.34	41.73
11:18	302.72	319.56	46.88	35.14
11:24	316.43	297.52	43.47	30.18
11:30	346.37	339.01	44.22	35.84
11:36	385.43	380.67	42.95	43.07
11:42	424.75	403.33	48.71	42.17
11:48	527.65	461.06	54.57	49.37
11:54	606.63	555.20	55.68	45.73
12:00	1082.14	1083.06	82.14	68.59
AVERAGE	398.39	402.72	94.93	128.42
F-all	5.15**	5.40**	21.77**	40.25**
F-open, 9:06	1.95	5.15*	20.66**	35.42**
F-open, inn	6.36*	10.04**	23.89**	42.98**
F-open, close	3.78	1.03	22.73**	42.76**
F-9:06, inn	1.32	1.44	6.35*	15.45**
F-9:06, close	8.77**	8.35**	2.19	14.05**
F-close, inn	13.60**	12.62**	1.39	0.05

Notes:

F stands for F-statistic; 'all' represents all trade intervals; 'open' represents the open trade; '9:06' represents the first six-minute interval (9:00–9:06) excluding the open trade; 'inn' represents the interior periods from 9:06 to 11:54; 'close' represents the last trade interval (11:54–12:00). *, ** indicates significance at the 1% and 10% levels, respectively.

Table 3
Informed and Uninformed Orders

<i>Time Interval</i>	<i>Real Orders</i>					<i>Waiting Orders</i>					<i>Informed/Uninf.</i>
	<i>BUY</i>		<i>SELL</i>			<i>BUY</i>		<i>SELL</i>			
	<i>Informed</i>	<i>Uninf.</i>	<i>Informed</i>	<i>Uninf.</i>		<i>Informed</i>	<i>Uninf.</i>	<i>Informed</i>	<i>Uninf.</i>		
Open	410.53	254.17	545.21	293.91		714.92	380.72	1291.89	588.49	1.95	
9:06	317.76	159.05	330.31	145.50		86.78	39.22	156.24	62.09	2.20	
9:12	311.99	163.25	341.53	179.17		89.08	40.56	122.31	65.66	1.93	
9:18	301.83	155.76	287.22	154.94		65.14	37.55	95.87	49.40	1.89	
9:24	293.29	150.55	267.68	143.34		64.12	33.62	79.37	41.44	1.91	
9:30	270.57	142.33	258.38	141.13		44.15	27.75	74.54	39.09	1.85	
9:36	255.19	132.86	269.56	140.43		57.27	27.73	64.11	34.62	1.93	
9:42	243.77	128.10	244.79	133.25		46.67	27.25	53.24	30.39	1.84	
9:48	213.68	118.02	231.72	125.27		35.95	24.04	46.57	26.12	1.80	
9:54	207.41	113.95	221.85	122.73		37.02	22.25	42.58	25.12	1.79	
10:00	202.89	111.23	220.26	120.64		30.29	20.45	44.38	24.69	1.80	
10:06	207.19	115.40	205.05	115.85		45.31	24.47	43.70	21.70	1.81	
10:12	208.87	116.20	215.99	118.52		40.44	21.60	37.95	20.97	1.81	
10:18	210.22	113.05	205.51	112.75		35.14	20.28	36.48	19.16	1.84	
10:24	195.79	109.21	194.72	108.36		29.88	16.66	28.33	16.62	1.79	
10:30	201.24	104.54	202.79	110.09		28.15	15.94	29.71	16.96	1.87	
10:36	184.86	101.21	197.74	106.01		27.68	15.86	31.67	15.01	1.86	
10:42	188.11	104.08	198.49	105.64		27.08	16.61	28.55	14.11	1.84	
10:48	194.38	111.38	180.62	100.62		25.60	17.00	28.98	13.96	1.77	
10:54	207.70	115.28	186.46	101.70		23.40	15.86	30.12	13.54	1.82	
11:00	192.76	111.89	192.19	105.98		27.50	15.36	27.11	14.07	1.78	
11:06	195.65	102.15	213.56	112.31		23.71	13.88	28.81	13.54	1.91	

11:12	200.04	108.67	218.15	117.05	28.12	16.22	28.34	13.40	1.86
11:18	194.74	107.99	207.13	112.42	29.27	17.61	22.91	12.24	1.81
11:24	201.94	114.49	189.56	107.96	27.09	16.39	18.51	11.67	1.74
11:30	222.46	123.91	218.02	120.99	28.11	16.11	24.02	11.82	1.81
11:36	254.19	131.25	246.91	133.76	26.42	16.52	29.40	13.67	1.89
11:42	279.52	145.88	259.22	144.11	29.94	18.77	28.22	13.95	1.85
11:48	346.69	180.97	295.71	165.35	33.94	20.63	33.75	15.62	1.86
11:54	389.84	216.80	354.22	200.98	34.61	21.07	29.51	16.22	1.78
12:00	727.71	354.44	704.48	378.58	53.94	28.20	45.82	22.76	1.95
AVERAGE	259.12	139.29	261.45	141.27	61.18	33.75	86.55	41.87	1.85
F-all	4.48**	6.11**	4.23**	7.54**	16.29**	35.39**	33.40**	49.30**	0.72
F-open, 9:06	0.95	4.57*	3.21	8.27**	14.99**	36.05*	28.79**	45.24**	0.29
F-open, inn	15.24**	41.64**	43.89**	70.63**	468.87**	1019.74**	961.91**	1390.40**	0.54
F-open, close	4.22*	2.30	0.77	1.47	16.72**	38.62**	35.25**	52.83**	0.89
F-9:06, inn	3.50	2.89	4.83*	1.01	26.59**	18.22**	97.89**	65.23**	2.68
F-9:06, close	7.60**	10.80**	5.54*	17.64**	2.19	1.88	12.64**	16.02**	3.50*
F-close, inn	98.07**	116.83**	85.60**	154.93**	3.28	2.76	0.11	0.01	0.15

Notes:

Informed orders = orders with size 20 lots; F stands for F-statistic; 'all' represents all trade intervals; 'open' represents the open trade; '9:06' represents the first six-minute interval (9:00–9:06) excluding the open trade; 'inn' represents the interior periods from 9:06 to 11:54; 'close' represents the last trade interval (11:54–12:00). *, ** indicates significance at the 1% and 10% levels, respectively.

support our third hypothesis, that is, traders tend to place conservative orders at the market open.

Another possible reason for large waiting orders at the open is related to the trading mechanism in the Taiwan stock market. The TWSE adopts an order-driven computerized trading system allowing only limit orders. There are no specialists and a 7% price limit at the open and intraday price limit in the inner trading periods and the close are imposed. As a result, investors may tend to place more conservative orders at the open. F-statistics indicate that real buy and real sell orders exhibit a J-curve pattern, which is consistent with the behavior of trading volume listed in Figure 1. In particular, $F_{\text{open, inn}}$ for real buy and sell orders are 6.36 and 10.04 respectively; and $F_{\text{close, inn}}$ for buy and sell orders are 13.60 and 12.62, respectively. On the contrary, waiting orders exhibit a reverse J-shaped pattern. Results in Table 2 indicate that while the largest buy order appears at the market open, real trading intentions are the strongest at the close. The huge number of real orders at the market close is consistent with both the portfolio-rebalance need and risk-sharing motive.

Table 3 shows that informed and uninformed traders adopt similar strategy, that is, they place large conservative orders at the market open. By definition, informed trader's order is larger than uninformed traders, we cannot make judgement on the relative importance of informed orders and uninformed orders in explaining the J-shaped pattern of trading volume merely based on order size. The last column of Table 3 shows the ratio of informed to uninformed orders. The ratio allows us to examine if the relative trading behavior between informed and uninformed investors changes overtime. The range of the ratio is (1.77–2.20). According to the F-statistics, the ratio is not significantly different across different sessions. The only exception is that the ratio for the period '9:00–9:06' is significantly higher than that at the closing period. This indicates that the relative trading behavior between informed and uninformed investors is quite stable over time. In addition, it is of interest to see if a particular type of order is more likely to be executed at the open. We find that while the informed orders counts 62% of the total orders, only 41% of the executed orders are informed orders. This means that uninformed orders account for 59% of the executed orders even though they account for only 38% of the total orders. In

addition, 7.6% of informed orders and 10.7% of uninformed orders are executed at the open; the difference is statistically significant. These figures imply that small orders are more likely to be executed at the open. An examination of the pricing behavior indicates that small orders tend to offer a better price than large orders. This explains the relatively high execution rate for small orders at the market open.

(ii) *Regression Analysis*

To investigate the role of information trade and liquidity trade in explaining intraday pattern of trading volume, we conduct the following regression analysis and report the results in Table 4:

$$\text{VOL}_t = a_0 + a_1 \text{INFB}_t + a_2 \text{INFS}_t + a_3 \text{UNFB}_t + a_4 \text{UNFS}_t + \varepsilon_t \quad (1)$$

where VOL_t is the trading volume at time interval t ; INFB_t and INFS_t are the buy and sell orders placed by informed traders, while UNFB_t and UNFS_t are buy and sell orders of uninformed traders. For each of the trading intervals, the above regression is estimated for each of the 30 sample firms, respectively. Reported coefficient is the average of the coefficients for the 30 firms. The t -statistics are calculated by using the coefficients obtained from the regression for each of the sample firms.

Table 4 shows that trading orders placed by both informed and uninformed traders are significantly related with trading volume in all time intervals. However, the explanatory power is the lowest at the market open and is the highest at the market close (adjusted R^2 are 0.495 and 0.870 for the market open and market close respectively). This implies that most orders at market open are non-executable. In terms of the value of estimated coefficients, the impact of uninformed orders is greater than that of informed orders. In particular, coefficients of UNFB are greater than that of INFB for all time intervals except at 11:48–11:54. For the sell orders, coefficients of UNFS are uniformly greater than that of INFS except at 10:12–10:18. While both information trading and liquidity trading can explain intraday trading volume, the impact of liquidity trading is relatively larger. This is consistent with the study by Lee, Lin and Liu (1999) which find that small investors provide liquidity to the market.

Table 4

Volume Regression—Total Orders

$$\text{VOL}_t = a_0 + a_1 \text{INFB}_t + a_2 \text{INFS}_t + a_3 \text{UNFB}_t + a_4 \text{UNFS}_t + \varepsilon_t$$

<i>Interval</i>	<i>INTERCEP</i>	<i>INFB</i>	<i>INFS</i>	<i>UNFB</i>	<i>UNFS</i>	<i>Adjusted R²</i>
Open	-177.067**	0.14024**	0.06796**	0.20174**	0.14793**	0.4951
9:06	-112.328**	0.40618**	0.23558**	1.09961**	0.78831**	0.7895
9:12	-106.836**	0.37540**	0.22833**	0.95579**	0.66170**	0.7651
9:18	-82.129**	0.42648**	0.23936**	1.16678**	0.48987**	0.7981
9:24	-62.670**	0.48336**	0.22434**	1.01721**	0.54073**	0.7750
9:30	-73.169**	0.47751**	0.26483**	0.90254**	0.75828**	0.7447
9:36	-69.443**	0.38743**	0.38401**	0.98304**	0.68453**	0.7608
9:42	-40.543**	0.41405**	0.39811**	0.84710**	0.64315**	0.7524
9:48	-37.101**	0.52033**	0.40850**	0.60507**	0.80262**	0.7573
9:54	-42.590**	0.46304**	0.41332**	1.01925**	0.54311**	0.7361
10:00	-50.423**	0.49785**	0.32878**	0.93595**	0.77886**	0.7590
10:06	-12.428	0.37317**	0.42435**	1.14129**	0.42536**	0.7780
10:12	-32.656**	0.46900**	0.41323**	0.75377**	0.59591**	0.7537
10:18	-18.047	0.43212**	0.45091**	1.02498**	0.36773**	0.7633
10:24	-18.165	0.49888**	0.38710**	0.86846**	0.58085**	0.6993

10:30	-49.270**	0.46198**	0.39674**	0.96970**	0.84006**	0.7612
10:36	-63.287**	0.51419**	0.42454**	0.99913**	0.87841**	0.7621
10:42	-44.263**	0.51057**	0.45332**	0.79265**	0.82062**	0.7577
10:48	-49.344*	0.48839**	0.44256**	1.06329**	0.82993**	0.7778
10:54	-37.729**	0.62150**	0.26850**	0.80926**	1.08982**	0.7849
11:00	-29.904*	0.48771**	0.40427**	0.83176**	0.83262**	0.7740
11:06	-102.849*	0.37685**	0.58740**	0.95854**	1.06801**	0.7950
11:12	-30.498**	0.40893**	0.52204**	0.76776**	0.96060**	0.7838
11:18	1.043	0.49421**	0.42080**	0.70429**	0.76029**	0.7700
11:24	-15.131	0.40428**	0.37986**	0.94874**	0.81792**	0.7396
11:30	-30.893*	0.54376**	0.55733**	0.82389**	0.71485**	0.7979
11:36	-49.558**	0.50999**	0.47605**	0.99202**	1.00933**	0.7936
11:42	-33.809	0.52192**	0.56749**	0.67404**	0.92178**	0.7871
11:48	0.374	0.63447**	0.49797**	0.79482**	0.87166**	0.8086
11:54	-19.527	0.64526**	0.52474**	0.59342**	1.04824**	0.8535
12:00	92.139*	0.59978**	0.66907**	0.92636**	1.15506**	0.8695

Notes:

VOL_t is the trading volume at time interval t ; $INFB_t$ and $INFS_t$ are the buy and sell orders placed by informed traders, while $UNFB_t$ and $UNFS_t$ are buy and sell orders of uninformed traders. For each of the trading intervals, the above regression is estimated for each of the 30 sample firms, respectively. Reported coefficient is the average of the coefficients for the 30 firms. The T -statistics are calculated by using the coefficients obtained from the regression for each of the sample firms. *, ** indicates significance at the 1% and 10% levels, respectively.

Table 5

Volume Regressions—Real/Waiting Orders

$$\text{VOL}_t = a_0 + a_1 \text{INFBR}_t + a_2 \text{INFSR}_t + a_3 \text{UNFBR}_t + a_4 \text{UNFSR}_t + a_5 \text{INFBW}_t + a_6 \text{INFSW}_t + a_7 \text{UNFBW}_t + a_8 \text{UNFSW}_t + \varepsilon_t$$

<i>Interval</i>	<i>INTERCEP</i>	<i>INFBR</i>	<i>INFSR</i>	<i>UNFBR</i>	<i>UNFSR</i>	<i>INFBW</i>	<i>INFSW</i>	<i>UNFBW</i>	<i>UNFSW</i>	<i>Adjusted R²</i>
Open	-155.664**	0.29827**	0.22743**	0.57864**	0.52367**	0.01383	0.01743	0.07496	0.03672	0.6502
9:06	-57.263**	0.46459**	0.33230**	1.27739**	1.15697**	0.01530	0.04144	-0.29319	-0.08964	0.8327
9:12	-69.310**	0.47046**	0.30600**	1.17194**	0.92263**	0.05222	-0.02205	-0.05269	-0.06593	0.8040
9:18	-66.464**	0.47786**	0.34084**	1.18693**	0.67539**	0.18133	0.15628	0.67285*	-0.15800	0.8306
9:24	-47.357**	0.55347**	0.34415**	1.13025**	0.73423**	0.09041	-0.06501	0.28633	-0.38708	0.8084
9:30	-62.382**	0.55127**	0.37954**	1.07483**	1.08425**	-0.05829	-0.12886	-0.10922	-0.63562	0.7828
9:36	-58.385**	0.41273**	0.48126**	1.19042**	1.04315**	0.25194	0.00040	-0.33523	-1.04445**	0.8033
9:42	-34.847**	0.49309**	0.39765**	1.15042**	0.79481**	0.08256	0.10776	1.15042**	-0.08331	0.7844
9:48	-43.789**	0.55435**	0.50039**	0.92682**	0.94770**	0.01136	-0.20452*	-0.36881	-0.25390	0.7839
9:54	-41.114**	0.49486**	0.45474**	1.21168**	0.75340**	0.01812	0.03731	0.86169*	-0.21204	0.7809
10:00	-55.563**	0.50462**	0.47818**	1.05875**	0.91820**	-0.03817	-0.21786	0.17601	0.00599	0.7962
10:06	-47.207**	0.48700**	0.51142**	1.33100**	0.66480**	0.03155	0.15123	0.51694	-1.09909**	0.8233
10:12	-41.729**	0.51513**	0.47417**	0.81963**	0.90082**	0.14991	0.13887	0.32271	-0.77314*	0.7883
10:18	-39.743*	0.47025**	0.49287**	1.20416**	0.66784**	0.15341	-0.04723	0.03471	-0.58885	0.7963

10:24	-20.057	0.55099**	0.48846**	0.98342**	0.82527**	0.08318	-0.34249*	-0.00261	-0.58373	0.7344
10:30	-47.761**	0.48630**	0.45592**	1.07349**	0.93003**	0.09920	0.20703	-0.03461	-0.03698	0.7850
10:36	-62.282**	0.54169**	0.46699**	1.15224**	1.11969**	0.34842	0.03618	0.31207	-0.86429*	0.8010
10:42	-49.119**	0.53659**	0.56996**	0.98865**	1.09666**	0.01366	-0.04675	-0.45243	-1.44598*	0.7974
10:48	-63.342**	0.52269**	0.53338**	1.19527**	1.29695**	-0.22299	-0.35624	-0.55371	-0.72369	0.8203
10:54	-46.776**	0.64485**	0.33462**	0.99797**	1.29082**	-0.04600	0.16212	-0.33889	-0.45035	0.8078
11:00	-54.993**	0.51107**	0.53219**	1.02295**	1.07469**	-0.04818	-0.23189	0.05457	-0.65205	0.8097
11:06	-97.988**	0.41097**	0.58819**	1.12968**	1.27574**	-0.02716	0.67099*	0.24515	-0.54198	0.8257
11:12	-42.948**	0.48394**	0.55487**	0.82399**	1.15251**	-0.07129	0.22644	0.67905	-0.51464	0.8082
11:18	-22.069	0.56440**	0.47232**	1.05275**	0.97542**	-0.17194	-0.09458	-0.20426	-2.19387**	0.8057
11:24	-19.981	0.40480**	0.42062**	1.13585**	1.02623**	0.46152	0.41422	-0.11928	-1.22901*	0.7714
11:30	-50.916**	0.60032**	0.55558**	0.98584**	1.06398**	-0.12989	0.50911*	0.00331	-1.52084*	0.8231
11:36	-57.117**	0.52569**	0.51095**	1.07626**	1.28282**	-0.04392	0.26476	-0.54067	-1.25610*	0.8188
11:42	-70.041**	0.55269**	0.63671**	0.88167**	1.12054**	0.24280	-0.57630	1.42087	-0.26787	0.8288
11:48	-42.284**	0.70395**	0.58829**	0.91922**	1.08144**	0.03681	-0.10590	0.25191	-0.22031	0.8338
11:52	-35.678*	0.67791**	0.51020**	0.66898**	1.18555**	0.43140	0.59116	0.27954	-1.18646	0.8780
12:00	48.457	0.62460**	0.70482**	1.01444**	1.25638**	0.41026	0.47690	-0.48833	-1.14357	0.8876

Notes:

VOL_t is the trading volume at time interval t . For the independent variables, INF and UNF stand for informed and uninformed traders, respectively. The fourth character identifies whether it is a sell (S) or a buy (B) order. The final character indicates whether it is a real (R) or a waiting (W) order. For each of the trading intervals, the above regression is estimated for each of the 30 sample firms, respectively. Reported coefficient is the average of the coefficients for the 30 firms. The T -statistics are calculated by using the coefficients obtained from the regression for each of the sample firms. *, ** indicates significance at the 1% and 10% levels, respectively.

To investigate the impact of real and waiting orders, we decompose orders into real and waiting orders. Hence, trading volume is regressed on the real and waiting orders placed by informed and uninformed traders, i.e.:

$$\begin{aligned} \text{VOL}_t = & a_0 + a_1 \text{INFBR}_t + a_2 \text{INFSR}_t + a_3 \text{UNFBR}_t \\ & + a_4 \text{UNFSR}_t + a_5 \text{INFBW}_t + a_6 \text{INFSW}_t \\ & + a_7 \text{UNFBW}_t + a_8 \text{UNFSW}_t + \varepsilon_t. \end{aligned} \quad (2)$$

For the independent variables, INF and UNF stand for informed and uninformed traders, respectively. The fourth character identifies whether it is a sell (S) or a buy (B) order. The final character indicates whether it is a real (R) or a waiting (W) order.

As shown in Table 5, waiting order has insignificant impacts on trading volume in most of the cases. In particular, none of the coefficients of INFBW is significant. Therefore, the J-shape pattern of trading volume is mainly driven by real orders. Compared with Table 4, the coefficients of real orders (INFBR, INFSR, UNFBR and UNFSR) are higher. Therefore, waiting orders under-estimate the relationship between trading intention and intraday pattern of trading volume. While the significant level of informed and uninformed orders are the same, coefficients of uninformed orders (UNFBR and UNFSR) are higher than those of informed orders (INFBR and INFSR) in all instances. This further supports the findings in Table 4; liquidity trading plays a more important role than informed trading in explaining the intraday pattern of trading volume.

(iii) Robustness of the Results

To test the robustness of the above results, we replicate the above analyses using alternative definitions of real/waiting orders and uninformed/informed orders as stated in Table 6. Moreover, we attempt different regression specifications explained below. The distributions of different types of orders based on various classification criteria are presented in Figure 2. Figure 2 illustrates that intraday patterns of different types of orders are parallel to those reported in Table 3. In particular, real orders of both informed and uninformed investors follow a 'J' shaped pattern. On the contrary, waiting orders are extremely high at the

open but decrease dramatically afterwards. A slight difference is that for cases (3), (4), (5), and (6), real orders at the open are less than those in the period '9:00–9:06'. To sum up, the distributions of orders reported in Tables 2 and 3 are invariant to classification criteria.

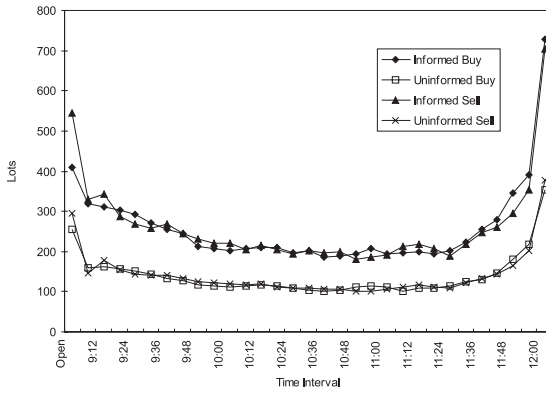
For the regression analysis, we attempt the following alternatives: (a) pooling all firms in each interval and estimating equations (1) and (2); (b) pooling all firms across all time intervals and adding 31 time dummies; trading volume is then regressed on the dummies and the interaction terms of dummies and the independent variables as stated in equations (1) and (2); (c), same as (a) but including stock returns as control variables; and (d) same as (b) but including stock returns as control variables. Table 7 summarizes the key results for alternative regression specifications and order classification schemes. Panel A of Table 7 indicates that the main results drawn from Table 4 hold. In particular, uninformed orders have larger coefficients than the informed orders. When pooling data is used, a major different result is found in Panel B – most of the coefficients of waiting orders are significantly different from zero. However, the coefficients of real orders are still uniformly greater than those of waiting orders. The coefficients of uninformed orders are greater than those of informed orders for real orders, but the reverse relationship is found for waiting orders for cases 3 and 5. Except slight variations, the main conclusions inferred from Tables 4 and 5 still hold. Our earlier results are robust with respect to the order classification scheme and regression specifications.

5. CONCLUSIONS

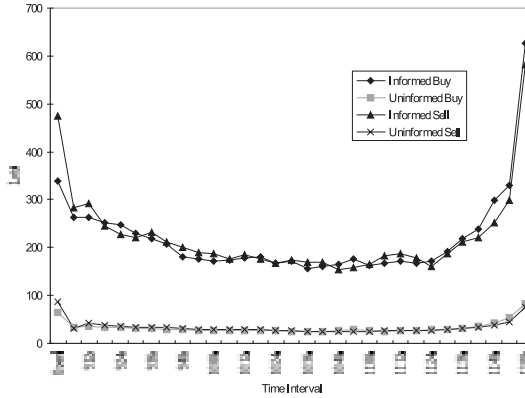
Previous theoretical researches suggested that trading volumes depend on traders' exogenous liquidity needs, information flows, and the strategic interactions between informed and liquidity traders. Constrained by order flow data unavailability, previous studies examine indirectly concentrated trading using trading volume data. The pivotal contribution of this study is to measure the intraday trading behavior of informed and uninformed investors directly using a complete limit order book data of the Taiwan Stock Exchange. We examine the intraday pattern of

Figure 2

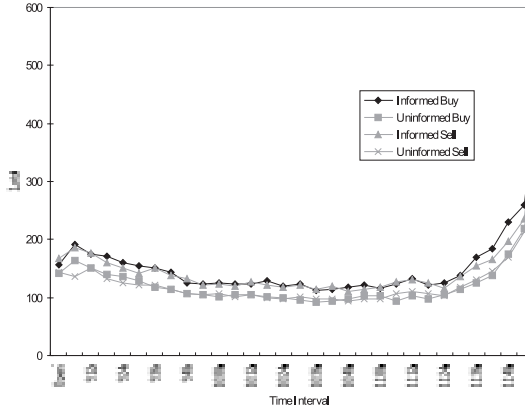
Distributions of Orders for Different Classification Schemes



Case 1
Real Orders

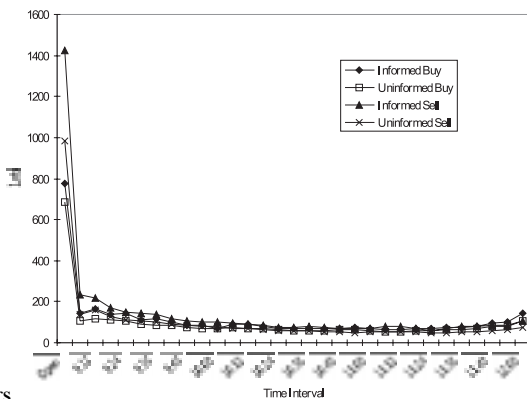


Case 2
Real Orders

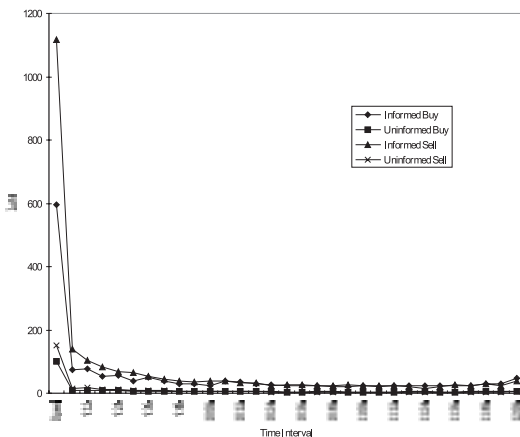


Case 3
Real Orders

Figure 2 (Continued)



Case 1
Waiting Orders



Case 2
Waiting Orders

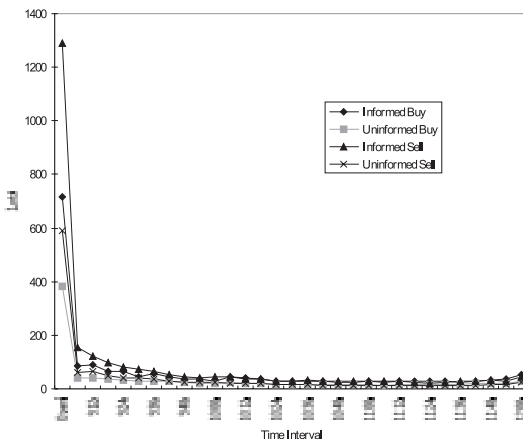


Figure 2 (Continued)

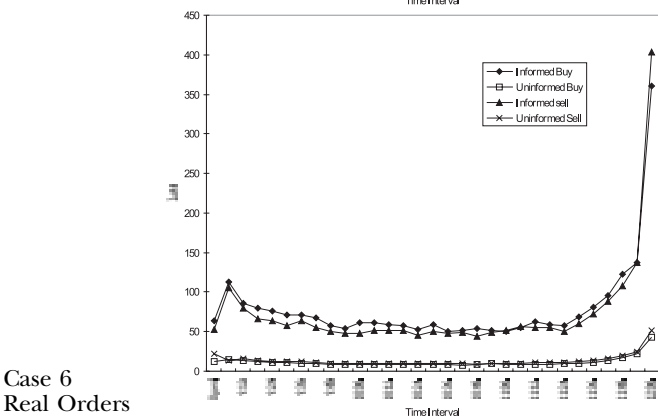
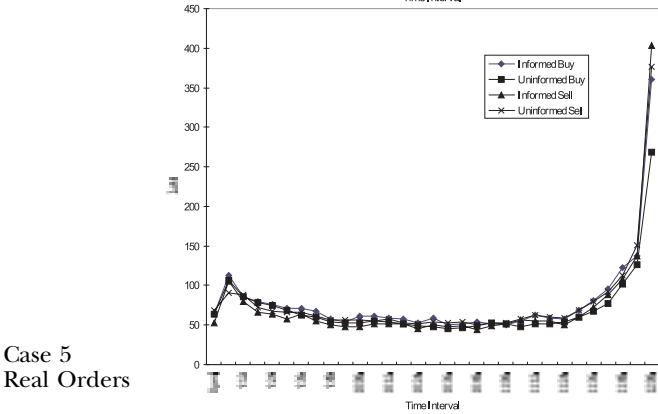
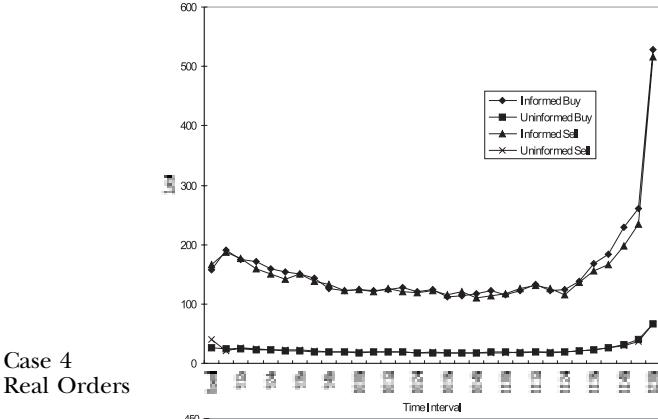
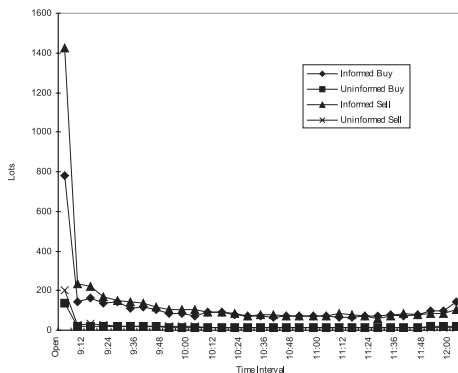
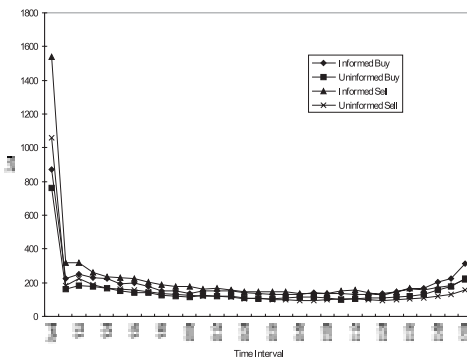


Figure 2 (Continued)

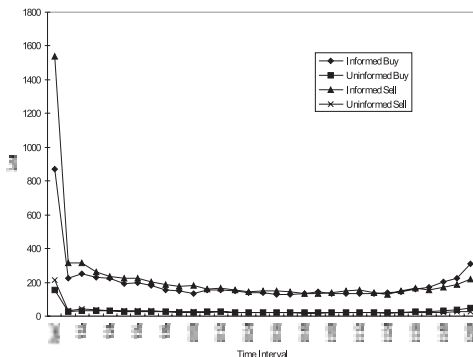
Case 4
Waiting Orders



Case 5
Waiting Orders



Case 6
Waiting Orders



Note:

Case 1–Case 6 are referred to different classification schemes as defined in Table 6.

Table 6
Alternative Specifications of Informed/Uninformed and Real/Waiting Orders

<i>Order Type</i>	<i>Case 1 (the base case)*</i>	<i>Case 2</i>	<i>Case 3</i>	<i>Case 4</i>	<i>Case 5</i>	<i>Case 6</i>
Informed orders	orders > 20 lots	orders > 20 lots	orders > 20 lots	orders > 20 lots	orders > 20 lots	orders > 20 lots
Uninformed orders	orders ≤20 lots	orders < 5 lots	orders ≤20 lots	orders < 5 lots	orders ≤20 lots	orders < 5 lots
Real buy orders	order price ptp - 2 ticks	order price ptp - 2 ticks	order price ≥ptp	order price ≥ptp	order price ≥ptp + 2 ticks	order price ptp + 2 ticks
Real sell orders	order price ≤ptp + 2 ticks	order price ≤ptp + 2 ticks	order price ≤ptp	order price ≤ptp	order price ≤ptp - 2 ticks	order price ≤ptp - 2 ticks
Waiting buy orders	order price < ptp - 2 ticks	order price < ptp - 2 ticks	order price < ptp	order price < ptp	order price < ptp + 2 ticks	order price < ptp + 2 ticks
Waiting sell orders	order price > ptp + 2 ticks	order price > ptp + 2 ticks	order price > ptp	order price > ptp	order price > ptp - 2 ticks	order price > ptp - 2 ticks

Notes:

* ptp = price of the previous transaction.

Case 1 is the base case. Results reported in Table 1–Table 5 of the text are based on the definitions stated in Case 1.

Table 7

Comparison of Regression Results Among Different Specifications and Definitions of Real/Waiting Orders and Informed/Uninformed Orders

Panel A

Major Findings in Table 4

	Case 1				Case 2				Case 3				Case 4				Case 5				Case 6							
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>				
(1) Coefficients of informed orders and uninformed orders are significant in all time intervals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
(2) Coefficients of uninformed orders > coefficients of informed orders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Panel B

Major Findings in Table 5

	Case 1				Case 2				Case 3				Case 4				Case 5				Case 6							
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>				
(1) Coefficients of real orders are significant	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Coefficients of waiting orders are insignificant	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Table 7 (Continued)

(2) Coefficients of real orders >																								
Coefficients of waiting orders																								
- for informed orders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
- for uninformed orders	✓	✓	✓	✓	?	?	?	?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
(3) Coefficients of uninformed orders >																								
Coefficients of informed order																								
- for real orders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
- for waiting orders	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	✓	?	✓	✓	X	X	X	X	?	?	?	?

Notes:

Case 1 to Case 6 are different from each other in the ways to classify orders. The definitions of real/waiting and informed/uninformed orders for each case are shown in Table 6. (a)–(d) represent different regression specifications. (a) For each time interval, data for all the sample firms are pooled, equations (1) and (2) are then estimated for each time interval; (b) Data for all the sample firms across all time intervals are pooled. Dummies for the 31 time intervals are added, trade volume are then regressed on the interval dummies and the interaction term between dummies and the independent variables stated in equation (1) and (2); (c) Same as (a), adds stock returns as control variables; (d) Same as (b), adds stock returns as control variables.

‘✓’: more than 2/3 of the coefficients are consistent with the result listed in the first column; ‘X’: more than 2/3 of the coefficients are opposite to the result listed in the first column; ‘?’: less than 2/3 but more than 1/3 of the coefficients are consistent with the result listed in the first column.

information and liquidity orders as well as the ordering strategies of both informed and uninformed (liquidity) traders.

The results of this study indicate that investors have strong desires to place orders at the market open and the close. While the largest orders are placed at the open, only mediocre trading volume is observed. This implies that traders tend to place conservative orders at the open. To take into account the strategic interaction of informed and liquidity traders, we classify total orders into real orders and waiting orders. Such a classification allows us to distinguish real trading intention from desire for price priority. Our findings show that real orders from both informed and uninformed traders exhibit a J-shaped intraday pattern, which is consistent with the intraday pattern of trading volume. On the other hand, a reverse J-shaped pattern of waiting orders is found as orders at the market open are less likely to be executed. Investors tend to 'test' the market when uncertainty at the market open is high. However, as trading is taking place, information is released and uncertainty is gradually resolved. As a consequence, the amount of waiting orders is significantly reduced.

Results from regression analysis indicate that both information and liquidity trading play an important role in explaining the intraday pattern of trading volume. We find that the impact of liquidity trade on trading volume is slightly greater than that of information trade. The possible reason is that uninformed orders provide liquidity to the market. Finally, waiting orders play a less significant role than real orders in determining the intraday pattern of trading volume. This pinpoints the importance of distinguishing real trading intention from desires for price priority in studying the regularities of trading volume.

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