THE EFFECT OF LIMIT ORDER BOOK INFORMATION ON INVESTORS WITH DIFFERENT RISK ATTITUDES

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ABSTRACT

The Taiwan Stock Exchange Corporation (TSEC) started to disclose information on the best five bid/ask prices and volumes ever since January 2, 2003. With such disclosure, investors can now judge the market conditions according to the limit order book information and then decide their order aggressiveness and order placement strategies. The purpose of this study is to investigate the relationships and effects of risk attitudes, limit order book information, and price clustering. Using random sampling, we administered the questionnaires to investors living in Taiwan from February 1, 2012 to May 1, 2012. The research results show there are in fact significant relationships among risk attitudes, limit order book information, and price clustering. Moreover, investors will conduct strategic trading behavior when they face price clustering.

JEL: G11, G14, G28

KEYWORDS: Best Five Bid/Ask Prices and Volumes, Risk Attitude, Limit Order Book Information, Price Clustering

INTRODUCTION

The two main trading mechanisms that model most of the securities markets around the world are the quote-driven system and the order-driven system. The Taiwan Stock Exchange Corporation (TSEC) is an order-driven, call auction market. It started to disclose information on the best five bid/ask prices and volumes ever since January 2, 2003. Information about unexecuted buy (sell) orders is disclosed from highest to lowest (lowest to highest) prices instantaneously. Investors can thus decide their order aggressiveness and order placement strategies by such limit order book information. The disclosure not only enhances information transparency, but also reduces the information asymmetry of uninformed traders. Previous studies on limit order book information have demonstrated that investors will decide their order aggressiveness and order placement strategies according to the order concentration, order flow, and spread in the limit order book (Biais, Hillion, & Spatt, 1995; Chan, 2005; Duong, Kalev, & Krishnamurti, 2009; Harris & Hasbrouck, 1996; Kaniel & Liu, 2006; Ma, Lin, & Cheng, 2008; Mark et al., 2000). Price clustering may also influence investors' trading behavior. When there are many orders standing ready at a particular limit price, this price is likely to become an obstacle. Prices cannot move from or through such a position until all relevant orders have been exhausted. The literature provides evidence of strategic trading behavior in which traders place buy (sell) orders one price tick higher (lower) than this clustering price in order to achieve trade priority (Kavajecz & Odder-white, 2004; Ahn, Cai & Cheung, 2005; Ascioglu, Comerton-Forder, & McInish 2007).

Risk attitudes refer to the attitude of investors when they face risk. Risk averters have lower risk tolerance than risk lovers (Yao, Gutter & Hanna, 2005). Many research studies have also found that demographic variables influence investors' risk attitude and trading behavior (Faff & McKenzie, 2004; Fan & Xiao, 2006; Grable, Lytton & O'Neill, 2004; Grable & Joo, 2004; Hallahan, Yao, Gutter & Hanna, 2005; Yao, Hanna & Lindamood, 2004). According to the literature, investors' trading behavior depends on risk attitude, limit order book information, price clustering, and demographic variables, but previous research on the best five bid/ask prices and volumes has focused on the relationships between bid-ask spreads and order flows, or on the effects of the disclosure of the best five bid/ask prices upon market depth. Little empirical evidence exists investigating the effects of the disclosure of the best five bid/ask prices on the order placement behavior of investors with different risk attitudes. Our study attempts to fill this gap. The aims of this study are: (1) to investigate the relationships and effects of risk attitudes,

limit order book information, and price clustering; (2) to analyze whether investors will conduct strategic trading behavior when price clustering occurs; (3) to analyze the implications of these results. The rest of this paper is organized as follows. Section 2 reviews previous research on limit order book information, price clustering, and investors' risk attitudes. Section 3 describes the data and method we employ. Section 4 reports the empirical results, and section 5 concludes the paper.

LITERATURE REVIEW

The two main trading systems that model most of the securities markets around the world are the quote-driven market system and the order-driven market system. In quote-driven systems, market makers supply the liquidity, and trading is carried out continuously through market makers who quote bid and ask prices at which they are willing to trade. Investors demand liquidity through the submission of market orders that are subsequently matched against the market makers' bid and ask prices. In order-driven systems, public limit orders provide liquidity to the market and investors demand liquidity through the submission of market orders. Limit orders result in better execution prices, but face a risk of non-execution. Market orders have no non-execution problem, but face a risk of execution price uncertainty. The Taiwan Stock Exchange Corporation (TSEC) is an order-driven market. Its trading begins at 9:00a.m., closes at 1:30p.m., and all stocks have a 7% daily price movement limit. In order to enhance market transparency and internationalization, the TSEC started to disclose information on the best five bid/ask prices and volumes ever since January 2, 2003. Information about unexecuted buy (sell) orders is disclosed from highest to lowest (lowest to highest) prices instantaneously. The best bid (ask) price means the highest (lowest) price of the unexecuted buy (sell) orders. Investors can judge the market conditions and then decide their order aggressiveness and order placement strategies using the best five bid/ask quotes and the associated depth at these quotes (the number of shares offered and demanded at these ten different quotes in the book). This disclosure not only enhances information transparency, but also alleviates the information asymmetry of uninformed traders.

Many studies examine the relationship between limit order book information and order placement strategy (Biais, Hillion, & Spatt, 1995; Buti & Rindi, 2013; Griffiths, Smith, Turnbull, & White, 2000). For example, Biais, Hillion, & Spatt (1995) use the best five bid and ask quotes and the associated depth at these quotes (the number of shares offered and demanded at these ten different quotes) to analyze the limit order book and the order flow in the Paris Bourse. Their findings present that investors will decide their order aggressiveness and order placement strategy according to the order concentration, order flow, and spread in the limit order book. Griffiths et al. (2000) examine the costs and determinants of order aggressiveness, noting that aggressive orders have larger price impacts, but smaller opportunity costs, than passive orders. Aggressive buy (sell) orders also tend to follow other aggressive buy (sell) orders and occur when bid-ask spreads are narrow and the depth on the same (opposite) side of the limit book is large (small). Chan (2005) examines the relationship between the state of the limit order book and previous price movements in order to investigate the order placement strategy in the Hong Kong Stock Exchange. Kaniel & Liu (2006) analyze informed traders' equilibrium choice of limit or market orders. Their empirical analysis suggests that informed traders prefer to use limit orders and that limit orders are more informative. Chiu, Chung, & Wang (2014) find both the state of limit order book and order size significantly influence institutional and individual traders' strategy on submission of limit order versus market order. Chang & Wu (2013) also find that individual and institutional investors submit and cancel orders differently depending on the depth of the limit order books.

Some scholars investigate the order aggressiveness of individual and institutional investors. Ma, Lin, & Cheng (2008) examines the impact of increasing pre-trade transparency on the intraday order placement strategies of individual and institutional investors, finding that greater transparency increases order aggressiveness and that greater transparency also changes trader order sizes. Duong et al. (2009) use an ordered probit regression model to investigate the determinants of the order aggressiveness of investors. Their results show that order aggressiveness is positively (negatively) correlated with depth on the same (opposite) side of the limit book. Price clustering is the tendency of prices to be observed at round numbers or at some numbers more frequently than others. Many studies have affirmed that a stock price

has the tendency for "stickiness at even eighths" (Neiderhoffer, 1966; Neiderhoffer & Osborne, 1966; Harris, 1991; Christie & Schultz, 1994; Christie et al., 1994). Some studies have observed prices clustering at 4 (Brown, Chua, & Mitchell, 2002), 8 (Brown & Mitchell, 2004), or 0 and 5 (Ahn, Cai, & Cheung, 2005; Narayan & Smyth, 2013). The literature proposes three main hypotheses to explain price clustering: the negotiation hypothesis, the attraction hypothesis, and the collusion hypothesis. Goodhart and Curcio (1991) use the attraction theory to explain price clustering in the foreign exchange market, while Christie & Schultz (1994) and Christie et al. (1994) argue that implicit collusion explains the tendency of Nasdaq market makers to avoid odd-eighth price quotes. Harris (1991) uses the negotiation hypothesis to explain the price clustering of NYSE/AMEX stocks, he finds that clustering increases with price level and volatility and decreases with capitalization and transaction frequency.

Price clustering may also influence investors' trading behavior. When there are many orders standing ready at a particular limit price, this price is likely to become an obstacle. Prices cannot move from or through such a position until all relevant orders have been exhausted. Support (resistance) levels occur when substantial selling (buying) pressure arrives to break through a particular price level. The literature offers evidence of strategic trading behavior in which traders place buy (sell) orders one price tick higher (lower) than this clustering price in order to get a trade priority (Kavajecz & Odder-white, 2004; Ahn, Cai, & Cheung, 2005; Ascioglu et al., 2007). Risk attitudes refer to the attitude of investors when they face risk. There are three types of risk attitude: risk aversion, risk neutrality, and risk preference. A risk averter prefers a more certain return to an alternative with an equal return, but which is more risky. On the other hand, a risk lover prefers a more uncertain alternative to an alternative with an equal, but less risky outcome. A risk neutral investor is interested only in whether the odds will yield a profit on average. Yilmazer & Lich (2013) showed that the portfolio asset allocation depends on the risk attitude. Many research studies also found that demographic variables influence investors' risk tolerance and trading behavior (Lemaster & Strough, 2013). Risk averters have lower risk tolerance than risk lovers (Yao, Gutter, & Hanna, 2005). Based on the above literature, the following hypotheses are developed.

Risk attitude has a significant effect on investors' reactions to limit order book information

Risk attitude has a significant effect on investors' reactions to price clustering

Investors' reactions to limit order book information have a significant effect on investors' reactions to price clustering.

Investors will change their trading behavior according to the limit order book information

Investors will conduct strategic trading behavior when they face price clustering

DATA AND METHODOLOGY

According to the research framework, the items of the questionnaire are designed for the four dimensions: demographic variables, risk attitude, investors' reactions to limit order book information, and investors' reactions to price clustering. These items are measured on Likert's five-point scale, ranging from 1 point to 5 points, denoting "very disagree", "disagree", "neutral", "agree", and "very agree", respectively. Using random sampling, we administered the questionnaires to investors living in Taiwan from February 1, 2012 to May 1, 2012. A total of 387 responses were distributed, and 314 usable responses were collected, for an acceptable response rate of 81%. We perform data analyses on SPSS 19.0, and the methods adopted include descriptive statistics analysis, reliability and validity analysis, factor analysis, and regression analysis.

RESULTS

Through descriptive statistics analysis, we are able to understand the distribution of participants' basic

attributes. (1) Gender: 86.9% of the subjects were male, and 13.1% were female. (2) Age group: the main group was 31-40 years old, taking up 46.2%, followed by the group of younger than 30 years old (24.8%), 41-50 years old (19.7%), and more than 50 years old (9.2%). (3) Education level: university education was the main group, taking up 43.3%, followed by college (40%), graduate school (22.9%) and high school education (12.7%). (4) Yearly income: most of the subjects (45.2%) earned NT$500,000-1,000,000 per year, 39.8% earned lower than NT$500,000, 14.9% earned more than NT$1,000,000. (5) Occupation: the major group was formed by those working in the manufacturing industry (20.1%), followed by service industry (15.0%), high-tech industry (12.7%), financial industry (12.1%), public servants (8.3%), students (3.8%), and others (28%).

As presented in Table 1, all the dimensions have a Cronbach's α greater than 0.6, which complies with the criterion proposed by Cuiedford (1965). Hence, the reliability coefficient (Cronbach's α) of the questionnaire is within the acceptable level. According to Kaiser (1974), data with a KMO value lower than 0.6 are not suitable for factor analysis. A KMO higher than 0.8 indicates that there is a common factor among the variables and that the data are suitable for factor analysis. This study adopts the principal component analysis and uses the Varimax to maximize the sum of variance of the loading factors. Factors with an eigenvalue greater than 1 and a factor loading greater than 0.4 are extracted (Zaltman & Burger, 1975). As shown in Table 1, all these indices are within the acceptable range, indicating the clustering method is adequate and meaningful.

Table 1: Reliability and Validity Analysis

Dimensions	Factors	Item No.	Factor Loadings	Eigen Values	Variance Explained (%)	Cronbach's A
Risk attitudes	risk preference	b2	0.709	2.246	25.241	0.644
		b1	0.692			
		b4	0.625			
		b3	0.561			
	risk aversion	b7	0.740	1.670	23.529	
		b5	0.730			
		b6	0.675			
Limit order book information	Order placement strategy impact	c1	0.861	2.846	39.590	0.762
		c2	0.861			
		c4	0.836			
	Order aggressiveness impact	c6	0.803	1.169	27.334	
		c5	0.725			
		c3	0.630			
Price clustering		d4	0.772	3.10 7	51.776	0.812
		d2	0.762			
		d1	0.752			
		d5	0.732			
		d6	0.867			
		d3	0.859			

This table shows the reliability and validity analysis. The Cronbach's α is used as a reliability coefficient. Factors with an eigenvalue greater than 1 and a factor loading greater than 0.4 are extracted

Table 2 and Table 3 present the one-sample t-test analyses on limit order book information and price clustering, respectively. The results show that all items of the questionnaire have a p-value less than 0.05, indicating that the investors did not show a non-zero reaction to the limit order book information and price clustering. The results in Table 2 show that investors will decide their order aggressiveness and order placement strategies according to the order concentration, order flow, and spread in the limit order book. Besides, all items in Table 3 have a mean greater than 3, meaning that investors will conduct strategic trading behavior by placing buy (sell) orders one price tick higher (lower) than this clustering price. These results support our hypotheses H4 and H5.

Table 2: One-Sample T-Test Analysis of Limit Order Book Information

Items Of The Questionnaire	Mean	H0: μ = 3	
		t-value	p-value
c1. When sell orders obviously increase, I will sell stocks as soon as possible.	2.465	-8.385	0.000
c2. When sell orders are obviously more than buy orders in the limit order book, I prefer short sales.	2.525	-7.569	0.000
c3. When sell orders in the order book are plenty, I will consider buying later.	3.445	7.331	0.000
c4. When buy orders in the order book are plenty, I feel relieved to submit a buy order.	2.751	-3.597	0.000
c5. When more buy orders are focused on a bid price far away from the best bid, I will adjust the bid price downward.	3.168	2.415	0.016
c6. When the spread between best bid and best ask is large, I will wait and submit a buy order after the spread narrows down.	3.439	6.514	0.000

This table shows the one-sample t-test analysis of limit order book information. The first column represents statement of each question in the dimension of limit order book information. The second, third, and fourth column represent mean, t-value of t-test analysis, and p-value, respectively.

Table 3: One-Sample T-Test Analysis of Price Clustering

Items Of The Questionnaire	Mean	H0: μ = 3	
		T-Value	P-Value
d1. When the price is clustering at 2nd best bid price, I will submit a buy order at best bid price.	3.143	2.112	0.035
d2. When the price is clustering at 5th best bid price, I will submit a buy order at 4th best bid price.	3.181	2.705	0.007
d3. When the price increases severely, I will submit a buy order at best ask price if price clustering is at best bid price.	3.407	6.080	0.000
d4. When the price is clustering at 2nd best ask quote, I will submit a sell order at best ask price.	3.334	5.056	0.000
d5. When the price is clustering at 5th best ask price, I will submit a buy order at 4th best ask price.	3.312	4.668	0.000
d6. When the price decreases severely, I will submit a sell order at best bid price if price clustering at best ask price.	3.506	7.564	0.000

This table shows the one-sample t-test analysis of price clustering. The first column represents statement of each question in the dimension of price clustering. The second, third, and fourth column represent mean, t-value of t-test analysis, and p-value, respectively.

Regression equation (1) was estimated to test whether investors' risk attitudes (RA) and limit order book information (LOB) will influence investors' impact upon price clustering (PC). Ordinary Least Squares estimates were obtained. The results are presented in Table 4. Table 4 shows that RA has significantly positive impacts on LOB and PC, and LOB has a significantly positive impact on PC, too. This implies that investors' reactions to limit order book information and price clustering are stronger when they present a risk preference. Furthermore, the stronger the investors' impact is on limit order book information, the stronger the impact is on price clustering. This again supports our hypotheses H1, H2, and H3. $\mathrm{PC} = \propto + \beta 1(\mathrm{RA}) + \beta 2(\mathrm{LOB})$ (1)

Table 4: Regression Analysis

	Dependent Variable			
	LOB	PC	PC	PC
Intercept	2.125***(0.000)	2.358***(0.000)	1.899***(0.000)	1.422***(0.000)
RA	0.277***(0.000)	0.315***(0.000)		0.440***(0.005)
LOB			0.477***(0.000)	0.193***(0.000)

*This table shows regression of PC on RA and LOB. RA, LOB, and PC represent investors' risk attitude, limit order book information, and price clustering, respectively. ***, **, and * indicate significance at the 1, 5, and 10 percent levels respectively.*

CONCLUDING COMMENTS

The Taiwan Stock Exchange Corporation (TSEC) started to disclose information on the best five bid/ask prices and volumes ever since January 2, 2003. With such disclosure, investors can now judge the market conditions according to the limit order book information and then decide their order aggressiveness and order placement strategies. The purpose of this study is to investigate the relationships and effects of risk attitudes, limit order book information, and price clustering. Using random sampling, we administered the questionnaires to investors living in Taiwan from February 1, 2012 to May 1, 2012. A total of 387 responses were distributed, and 314 usable responses were collected, for an acceptable response rate of 81%. We perform data analyses on SPSS 19.0, and the methods adopted include descriptive statistics analysis, reliability and validity analysis, factor analysis, and regression analysis. The research results show there are in fact significant relationships among risk attitudes, limit order book information, and

price clustering. Moreover, investors will conduct strategic trading behavior when they face price clustering. According to this research, limit order book information in fact influence investor's trading behavior. It indicates that the limit order book information is valuable for investors. From the viewpoint of a stock exchange, the TSEC should persist to disclose more information to enhance information transparency and alleviates the information asymmetry of uninformed traders. Besides, there are significant differences in investors' reactions to limit order book information and price clustering among investors of different risk attitudes. To avoid overreactions to information and over risk-taking behaviors, from the viewpoint of investors, investors should understand their own risk attitudes and appraise more careful before submit an order. The primary limitation is that we only considered risk attitudes and limit order book information in this study. There are still other determinants that will influence investors' impact upon price clustering. Future research can include these other variables into more comprehensive models that have possibly higher explanatory power.

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